DATE DUE

~~DEC 1 0 1991~~			
ANNEX			
~~MAR 1992~~			

GAYLORD PRINTED IN U.S.A.

BORNEO:

ITS

GEOLOGY AND MINERAL RESOURCES.

BY

DR. THEODOR POSEWITZ,

MEMBER OF THE ROYAL HUNGARIAN INSTITUTE, BUDAPEST.

TRANSLATED FROM THE GERMAN

BY

FREDERICK H. HATCH, PH.D., F.G.S.

OF THE GEOLOGICAL SURVEY OF ENGLAND AND WALES.

WITH MAPS AND ILLUSTRATIONS

LONDON: EDWARD STANFORD,

26 & 27 COCKSPUR STREET, CHARING CROSS, S.W.

1892

Dedicated by the Author

TO

HERR P. VAN DIJK,

KNIGHT OF THE LION, ORDER OF THE NETHERLANDS; CHIEF OF THE MINES IN THE DUTCH INDIES;

THE ZEALOUS PROMOTER OF SCIENTIFIC RESEARCH;

IN GRATEFUL REMEMBRANCE OF THE YEARS SPENT IN THE DUTCH COLONIES.

PREFACE.

A THREE years' residence in Borneo furnished me with the opportunity of making myself in some degree acquainted with the geology of that island. I lived for some time in the marshy districts in the southern part of the island (Bandjermassin): for several months I stayed in the dry plains (Diluvium) surrounding the mountain-chain which separates South from East Borneo, and had daily opportunities of studying these mountains (Barabei): I also resided in the Tertiary hill-land on the great river Barito, in the heart of the island, about four kilometres from the equator (Teweh): and before leaving Borneo I had an opportunity of visiting the coal mine in Pengaron, and of making an excursion into the charming district of Tanah-Laut, which presents in miniature the geological structure of Borneo.

As far as possible, in districts so far removed from civilisation, I made myself acquainted with the existing literature, and worked out my notes. I completed my work in the well-stocked library of the "Genootschap voor Kunst en Wetenschappen," in Batavia. Here I consulted the earlier Dutch literature, which is not everywhere accessible: and, on returning to Europe, I studied more recent writings.

In the present work I purpose giving an historical summary of the more important investigations, and a sketch of the present position of our knowledge of the geography and geology of Borneo.

I am well aware that it is a difficult task to write a description of an island which in part is wholly unknown, of which the separate districts have only been cursorily traversed, and of which, relatively, few parts are at all well known to us.

But, since, on the one hand, no attempt has ever been made to give a connected account of this island, and, on the other, the Dutch literature is practically unknown out of Holland, I believe that I am doing the reading public some service in summarizing the whole of the more important literature, the more so, as two-thirds of the island have been treated only by Dutch writers.

The chief part of the literature on Borneo consists of Dutch, and small part also of English writings; while the articles published in other languages are, with few exceptions, compilations drawn from English sources, the Dutch works being unavailable on account of the prevailing ignorance of that language.

As a natural consequence the knowledge of Dutch Borneo is, except in the mother-country, very small, in spite of the fact that the existing Dutch literature is fairly copious.

Without knowledge of the latter, however, it is impossible to give an exact picture of our present information, and this ignorance of the Dutch literature outside Holland is clearly shown in some of the foreign publications. Thus when the Austrian corvette ("Friedrich") in the years 1874 to 1876, navigated a portion of the coast of Borneo, Lehnert (in the book entitled "Um die Erde"), maintained that the whole of the island was as unknown as the interior of Africa; and in an article in the journal *Ausland* (No. 40 and 41, 1878), there are similar inaccuracies.

These mistaken views have already been combated by Professor Veth in the Preface to Rosenberg's work on the Malay Archipelago, and the correctness of Veth's statements have been recognised by the *Ausland,* in an article on the exploration of Borneo (1879, No. 75).

Equally erroneous are statements made by Schweiger-Lerchenfeld ("Borneo-Oesterreichische Monatsschrift für den Orient," 1886, No. 4). This writer says:—"Next to some districts in Central Africa, there are at present no countries so unknown as the two largest islands of our planet—Borneo and New Guinea. Our information with regard to both is restricted to the coast-line, and a few patches in the interior of the islands. . . . . With regard to the geological structure of the interior of the island (Borneo), there exist only suppositions. . . . . Up to the present no one has succeeded in navigating the larger rivers for any distance from the mouth. . . . ." and other similar inaccuracies.

This treatise furnishes, by the way, a fairly accurate guage of the ideas prevailing outside Holland with regard to Borneo. North Borneo is treated relatively more in detail, as more information is available; with regard to Dutch Borneo, on the other hand, Schweiger-Lerchenfeld gets his data from Lehnert, Oesterreicher, and Carl Bock.

While, no doubt, the Dutch are right in complaining of the gross ignorance of their literature, one cannot blame those who are unacquainted with the language, for passing over purely Dutch writings.

In the present work, however, the whole of the Dutch literature has been utilized, and a more complete picture of the island is given than has hitherto appeared in the German language. May it be judged truly but justly.

In conclusion I have to thank those gentlemen who have helped me in my work: in the first place, the mining-engineers with whom I became acquainted in the Dutch Indies, and chief among these, the then director of the mines in Batavia, P. Van Dijk; further the directors of the magnificent library of the "Bataviaasch Genootschap voor Kunst en Wetenschappen"; Mr. A. H. Everett, of Labuan; and last, but not least, the renowned specialist in affairs of the Dutch Indies, Professor P. J. Veth, of Holland.

INDEX TO THE LITERATURE.

THE whole of the literature dealing with Borneo is arranged chronologically, and, for purposes of ready reference, divided into five groups: into works of a general character, and into treatises dealing specially with South, West, East, and North Borneo.

Many of the journals, especially those which occur frequently, are indicated by abbreviations, as follows:—

The separate groups are indicated by letters:—

T. v. N. I. = Tydschrift voor Nederlandsch-Indië.
n. T. v. N. I. = natuurkundig tydschrift voor Nederlandsch-Indië.
T. v. N. en L. = Tydschrift voor Nyverheid en Landbouw.
J. v/h M. in N. I.=Jaarboek van het Mynwezen in Nederslandsch-Indië.
T. aardr. gen. Amst. = Tydschrift van het aardrykskundig genootschap te Amsterdam.
Byrd. T. L. en V. v. N. I. = Bydragen tot de taal-, land- en volkenkunde van Nederlandsch-Indië.
T. ind. T. L. en V. = Tydschrift voor indische taal-, land- en volkenkunde.
Jahrb. Min. u. Geol. = Jahrbuch für Mincralogie und Geologie.
Min. Mitt. Tschermak = Mineralogische Mittheilungen von Tschermak.
Mitt. geogr. Ges. Wien = Mittheilungen der k. k. geographischen Gesellschaft in Wien.
Jahrb. u. geol. Anstalt = Jahrbuch der k. ung. geologischen Anstalt.
Jahrb. geol. Reichsanst. = Jahrbuch der k. k. geologischen Reichsanstalt in Wien.
Quart. Journ. Geol. Soc. = Quarterly Journal of the Geological Society.
Journ. Geogr. Soc. of London = Journal of the Royal Geographical Society of London.
Proc. Geogr. Soc. London = Proceedings of the Royal Geographical Society of London.
Journ. St. Br. R. Asiat. Soc. = Journal of the Straits Branch of the Royal Asiatic Society.

Treatises dealing with	Borneo generally		by	B.
,,	,,	S. Borneo	,,	S.
,,	,,	W. ,,	,,	W.
,,	,,	E. ,,	,,	E.
,,	,,	N. ,,	,,	N.

Each of these is numbered serially.

In order to avoid quoting the whole of the title of a treatise, the number and letter is given, by means of which the treatise indicated can be found in the Index of Literature. For example:—Rant S. 20 = Rant: Ijzerert in Vet. Tanah-Laut n. T. v. N. I, or Hatton N. 48 = F. Hatton, North Borneo, etc.

The Malay words are spelt in the German manner. Thus instead of the Dutch *œ*, I write *a*, which also corresponds with the English method.

Lists of literature are given in the following works:—

Veth = W. 17 complete.
Kan = B. 47.
Le Monnier = N. 40.
De Seyff = B. 8.
Verbeek in J v/h M. (Indian treatises).

I.—TREATISES WHICH DEAL WITH BORNEO IN GENERAL = B.

1. C. L. M. Radermacher. "Beschryving van het eiland Borneo, voor zoo ver hetzelfde tot nu toe bekend is." (Verhand. Bat. Gen.) 1826 II.
2. E. Müller. "Levensberigt van G. Müller." (Indische Bij. p. 177–194).
3. P. Melville van Carnbée. "Over de hoogte der bergen in den ost-indischen Archipel." (T. v. N. I.) 1844 I.
4. De dood van G. Müller. ("Naar mededeelingen van Dr. Schwaner.") T. v. N. I. 1849 I p. 139.
5. "Jets omtrent de Borneo-sche steenkolen." (Indisch archief) 1850.
6. "Rapport betreffende de exploitatie van mynen in Ned. Indië." (T. v. N. I.) 1851 II.
7. "Verslag van proeven met indische steenkolen genomen in April 1852 aan boord van Z. M. stoomschip Vesuvius door." C. de Groot, P. A. Matthyssen en J. F. Koopman. (n. t. v. N. I.) III 1852.
8. R. F. de Seyff. "Overzicht der geographische en topographische verrigtingen gedurende onze heerschappy in den indischen archipel." (n. T. v. N. I.) 1856 XI.
9. S. Bleekrode. "Antimonium en platina van Borneo." (T. v. N. I.) 1858 I.
10. Dr. F. Hochstetter. "Nachrichten über die Wirksamkeit der Ingenieure für das Bergwesen in Niederländisch Indien." (Jahrbuch K. K. geol. Reichsanstalt) 1858. Brief resumé of literature dealing with Borneo, p. 286–290.
11. "Analysen von Borneo-Kohlen volgens der Berthier-schen Probe." (Jahrb. K. K. geol. R. A.) 1858 p. 173.
12. "Die Kohlenfelder im ost-indischen Ocean." (Nenes Jahrbuch f. M. u. G.) 1858.
13. P. Van Dyk. "Over de waarde van eenige ned. indishe Kolen-soorten." (n. T. v. N. I.) 1858 XV.
14. S. Bleekrode. "Eene Beschouwing over de Koolformatie van Borneo." (n. T. v. N. I.) 1858 XVII.
15. C. de Groot. "Een woord aan het publiek betreffende de Koolformatie van Borneo." (n. T. v. N. I.) 1859 XIX

15*a*. Von Gaffron. "Over staartmenschen op Borneo." (n. T.v. N. I.) Bd. XX.
16. S. Bleekrode. "Eenige woorden over de bruinkool van Borneo." (n. T. v. N. I.) 1861 XXIII.
17. C. de Groot. "Een tweede woord aan het publiek over de Koolformatie van Borneo." (n. T. v. N. I.) 1861 XXIII.
18. P. van Dyk. "Brief over de bruinkool van Borneo." (n. T. v. N. I.) 1861 XXIII.
19. L. C. D. van Dyk. "Neerland's vroegste betrekkingen met Borneo, den Solo-Archipel, Cambodja etc." Amsterdam 1862.
20. J. H. Kloos. "Geologische opmerkingen over de Kolen van Borneo." (T. v. N. I.) 1863 II.
21. C. de Groot. "Notes on the Mineralogy and Geology of Borneo and the adjacent islands." (Quart. Journal of the Geo. Soc.) 1863.
22. C. de Groot. "Overzicht van de voornaamste proeven omtrent mynontginning sedert een tiental jaren in Indië genomen." (n. t. v. N. I.) 1864 XXVI.
23. C. de Groot. "Vervolg van het overzicht van de voornaamste proeven omtrent mynontginning sedert een tiental jaren in Indië genomen." (n. T. v. N. I.) 1865 XXVIII,
24. W. H. de Grêve. "Petroleum of aardolie en haar vookomen in Ned. Indië." (T. v. N. en L.) 1865 VI.
25. J. H. Kloos. "Vorkommen und Gewinnung des Goldes auf der Insel Borneo." (Berg- und Hüttenmännische Zeitung) 1865 No. 34 n. 38 also in the T. v. N. I. 1866 II.
26. C. de Groot. "Verslag over de Borneo-steenkolen." (N. T. v. N. I.) 1868 XXX; also in the J. v/h. M. in N. I. 1878 II.
27. Bernelot Moens. "Laurit een nieuw mineraal van Borneo." n. T. v. N. I. 1868 XXX; dasselbe in den Annalen der Chemie und Physik Band 139 p. 116.
28. C. de Groot. "Aanwyzingen en mededeelingen op het gebied van mynontginning" in N. I. 1872.
29. Dr. P. A. Bergsma. "Aardbevingen op Borneo, Bangka en Billiton." n. T. v. N. I. 1873 XXXIII.
30. Dr. Fr. Schneider. "Geologische Uebersicht über den holländisch-ostindischen Archipel." Jahrbuch K. K. geol. Reichsanstalt 1876.
31. Tob Frh. von. Oesterreicher. "Die Umschiffung von Borneo durch S. M. Corvette Friedrich." Mitth. K. K. geogr. Gesellsch. in Wien 1876. Also in abstract together with Josef Lehnert's "Um die Erde" in Auslande 1878 No. 40 u. 41 under the title "Die Umsegelung Borneos."
32. R. D. M. Verbeek, Dr. O. Böttger, Dr. Th. Geyler, Prof. Dr. C. von Fritsch. "Die Eocänformation von Borneo und ihre Versteinerungen." J. v/h. M. in N. I. 1877 II. Also in the Paläontographica, and in the N. J. für Min. u. Geol." 1875.
33. A. Frenzel. "Mineralogisches aus dem ost-indischen Archipel," Min. Mitth. von Tschermak 1877 III.
34. "Die Erforschung Borneo's." Ausland 1879 No. 25. Relating to B. 31.

35. "Die Eocänformation von Borneo." J. v/h. M. in N. I. 1879 I. Continuation of B. 32.
36. Dr. Th. Geyler. "Ueber fossile Pflanzen von Borneo." J. v/h. M. in N. I. 1879 II.; also in the Paläontographica.
37. Dr. F. Schneidcr. "Geographische verspreiding der minerale bronnen in den oost-indischen Archipel." T. aardryks. Gen. te Amsterdam 1881,
38. R. D. M. Verbeek. "Geologische Notizen über die Inseln des niederländisch-ostindischen Archipels etc." Paläontographica Suppl. III; also in the Nat. verhandelingen der Akademie van wetenschappen 1881 XXI.
39. K. Martin. "Nene Fundorte von Tertiärgesteinen im indischen Archipel." J. v/h. M. in N. I. 1882 II.
40. Th. Pozewitz. "Die geologischen Arbeiten im ost-indischen Archipel- földtani Közlöny 1882."
41. Th. Pozewitz. "Unsere geologischen Kenntnisse von Borneo." Jahrbuch K. u geol. Anstalt 1882; also in "Ausland" 1884.
42. J. v. Lehnert. "Ueber Landbildnngen im Sunda-Gebiet." Deutsche Rundschau für Geographie und Statistik 1882.
43. C. Frh. v. Ettingshausen. "Zur Tertiärflora von Borneo." Sitzungsberichte der K. K. Akademie der Wissenschaften in Wien 1883 Band 88 p. 372.
44. Th. Posewitz. "Das Goldvorkommen in Borneo." Jahrbuch K. u. geol. Anst. 1885. Also in abstract in "Ausland" 1884 No. 25 under the title "Die Goldfelder Borneo's."
45. K. Martin. "Die wichtigsten Daten unserer geologischen Kenntnisse vom neiderländish-ostindischen Archipel." Bydragen tot de taal- land- en volkenknnde van Ned. Indië. 1883.
46. Th. Posewitz. "Das Kohlenvorkommen in Borneo," Jahrbuch K. u. geol. Anst. 1884. Also in abstract in "Ausland" 1884 No. 50 under the title "Die Kohlenfelder Borneo's."
47. Dr. C. M. Kan. "Histoire des découverts dans l'archipel indien." Wetenschappelyke voordrachten gehouden te Amsterdam in 1883 ter gelegenheid der Koloniale Tentoonstelling 1884.
48. K. Martin. "Wissenschaftliche Aufgaben, welche der geologischen Erforschung des indischen Archipels gestellt sind." Wetenschappelyke voordrachten etc. s. B. 47. 1884.
49. F. de Bas. "La cartographie et la topographie des Indes Orientales Néerlandaises." Wetensch. voordrachten etc. s. B. 47. 1884.
50. M. Ch. Vélain. "L'îsle de Borneo." Revue scientifique 1884 VII 3. Série. Excerpt from Posewitz B. 41.
51. Th. Posewitz. "Das Diamantvorkommen in Borneo." Jahrbuch K. u. geol. Anst. 1885. Dasselbe im Auszuge im "Ausland" 1886 No. 36 unter dem Titel "Die Diamantfelder Borneo's."
52. H. von Schweiger-Lerchenfeld. "Borneo." Oesterreichische Monatsschrift für den Orient 1886.
53. Th. Posewitz. "Die Salzlager Borneo's." Ausland 1886 No. 40.
54. Th. Posewitz. "Das Platinvorkommen in Borneo." Ausland 1887.

55. Th. Posewitz. "Das Petroleumvorkommen in Borneo." Ausland 1887.
56. Th. Posewitz. "Geologisches aus Borneo." (Formationen älter als Tertiär.) Ausland 1887.
57. Th. Posewitz "Das Gebirgssystem Borneo's." Mitth. geograph. Ges. in Wien 1888.
58. Th. Posewitz. "Höhlenvorkommen in Borneo." Ausland 1888.
59. Th. Posewitz. "Quecksilbervorkommen in Borneo." Ausland 1888.
60. Th. Posewitz. "Zinnerzvorkommen in Borneo." Ausland 1888.

Other Treatises, which have not been used, as they are not of Geographical or Geological Importance.

E. von Martens. "Im Binnenlande von Borneo." (Zeitschr. Ges. Erdkunde in Berlin) 1873. VII. p. 193–210.

Meyners d'Estrey. "Excursion dans les Indes hollandaises." Le Dousson superieur. (Explorateur géogr. et commercial) 1875 No. 3 p. 57–59.

Meyners d'Estrey. "Borneo." (Revue géogr. international) 1876 No. 12 p. 267–273.

F. W. Versteeg. "Distribution géographique des combustibles minéraux dans les îsles de la Sonde." (Congrès international scient. géogr.) Paris 1878 p. 187.

T. L. von Osterreicher. "Labuan." (Osterr. Monatsschrift für den Orient.) 1878 No. 12.

M. Denison. "Journal of an Excursion from Sarawak to Meri." (Journal Straits Branch R. Geogr. Soc.) 1882 III. Sem.

"Beschreibung der Westküste von Borneo zwischen deu Flüssen Pawan und Pontianak." (Annalen der Hydrographie) 1883 XI. No. 5

L. Delavaud. "Borneo." (Bull. soc. franco-hisp. port. de Toulouse) 1883 IV.

F. Grabowsky. "Ueber seine Reisen in Süd-ost Borneo." (Verh. Ges. f. Erdkunde in Berlin) 1884 p. 419.

Dr. L. Delger. "Borneo." (Bull. soc. r. de géogr. d'Anvers) 1887 XI.

C. Rogge. "Eene dienstreis in de binnenlanden van Borneo." T. med. aardr. gen. 1887 No. 12.

II.—SOUTH BORNEO = S.

1. Mr. J. H. Tobias. "Beschryving van Bandjermassing, de nederlandsche Hermes" unter dem Titel "Macassar" 1826 III.
2. L. Horner. "Verslag van een geologisch onderzoek naar het zuidoostelyk gedeelte van Borneo." Verhand. Bat, gen. 1837 XVII.
3. L. Horner. "Vorkommen von Platin und Diamanten auf Borneo." N. Jahrbuch f. Mineralogie von Leonhard und Bronn, 1843 p. 209 und Poggendorf's "Annalen der Physik" LV. p. 526. (Auszug von. S. 2.)
4. M. J. Halewyn. "Borneo, eenige reizen in de binnenlanden van dat eiland in het jaar" 1824, T. v. N. I. I Deel 1 p. 401-403 ; Deel 2 p. 1-25, 81-102, 183-200 ; containing topographical information.

4*a*. "Beschryving der diamantmynen te Soengei Roenti in Bandjermassin in 1824." T. v. n. I. I 1838 Deel 2.

4*b*. "Beschryving van de bewerking der mynen te Bandjermassin." T. v. N. II. 1838 Deel 1.

5. "Diamantmynen op Borneo's Zuid- en Oostkust." Indisch Magazyn 1845.

6. P. J. F. Becker. "Het distrikt Poeloe-Petak in Z. O. Borneo." Indisch archief 1849 I.

7. R. J. F. Becker. "Reis van Poeloe-Petak naar de binnenlanden van Borneo langs de Kapoeas rivier." Indische archief 1849 I.

7*a*. J. G. H. Gallois. "Beschryving der steenkolenmynen in den berg Pengaron te Bandjermassin." T. v. N. I. 1849 II.

8. G. M. Bleekman. "Een bezoek aan de steenkolenmyn van Pengaron." n. T. v. N. I. 1850 I.

9. C. M. Schwaner. "Resultaten van een onderzoek naar den Baritostroom ten opzichte zyner bevaarbaarheid voor grootere vaartuigen." Indisch archief 1850.

10. H. von Gaffron. "Verslag over de goudmynen in het westelyk gedeelte van Tanah-Laut." n. T. v. N. I. 1851 II.

11. "Reise aanteekeningen van den heer Weddik." T. v. N. I. 1851 II.

12. "Uitgestrektheid der Kolenlagen van Riam en Pengaron." n. T. v. N. I. 1851 II

13. J. H. Croockewit. "Reis naar en aanteekeningen betreffende de steenkolen van Batoe-belian na nagelaten schriften van Dr. Schwaner." n. T. v. N. I. 1852 III.

14. "Steenkolen voorkomende op drie palen z. o. van Banjoe-irang naby de rivier Maloeka." n. T. v. N. I. 1853 IV.

15. H. von. Gaffron. "Mededeeling aangaande den Ijzererts gevonden ten Noorden van Kampong Tambaga in Tanah-Laut." n. T. v. N. I. 1853 V.

16. Dr. C. A. L. M. Schwaner. "Borneo." Beschryving van het stroomgebied van den Barito en reizen langs eenige voorname rivieren van het zuidoostelyk gedeelte van dat eiland. (published by the Kon. ned. Instituut voor Taal-, Land- en Volkenkunde van Ned. Indie) 1853 und 1854,

17. H. von Gaffron. "Geognostische tabel der rotssoorten van den berg Pengaron. n. T. v. N. I. 1854 VI.

18. Böcking. "Analysen von Platina-Erz von Borneo." Annalen der Chemie und Pharmacie. Band XCVI p. 243. 1855.

19. H. F. E. Rant. "Onderzoek naar Kolen aan de rivier Assem-assem in het Tanah-Laut." n. T. v. N I. 1856 X.

20. H. F. E. Rant. "Ijzererts in het Tanah-Laut." n. T. v. N. I. 1856 X. Also in J. v/h. M. in N. I. 1873 I.

21. "De steenkolen in het ryk van Bandjermassin." T. v. N. I. 1857 II. (From papers left by Dr. Schwaner "reis in de vorstenlanden 1844.")

22. S. Müller. "Reizen in den indishen Archipel." 1. reis in het zuidelyk gedeelte van Borneo gedaan in het jaar 1836. 2. reis door een gedeelte der Tanah-Laut-landen. Published by the Kon. ned. instituut voor taal-, landen volkenkunde van Ned. Indië 1857.

23. C. de Groot. "Zuid-en Oosterafdeeling van Borneo." n. T. v. N. I. XIV. Also in J. v/h. M. in N. I. 1874 II.

24. M. G. Maks. "Reis langs de Kahajan, in de Zuid- en Oosterafdeeling van Borneo." T. v. indishe T. L. en V. 1857 Deel VI.

25. S. Bleekrode. "Antimonium en Platinum op Borneo." tydschrift "de volksvlyt" 1857. In abstract in Poggendorf's Annalen Band CIII p. 656 and also in T. v. N. I. 1858 I.

26. S. Bleekrode. "Platinaerts van Goenong Lawak." Nieuw tydschrift voor volksvlyt 1859 I.

27. "Beschryving van het westelyk gedeelte van de Zuid- en Oosterafdeeling van Borneo." Bydragen tot de t. l. en v. van N. I. 1860. (Compiled by Pynappel from v. Gaffron's four reports.)

28. Bangert. "Verslag der reis in de binnenwaarts gelegen streken van Doesson Ilir." T. voor indische T. L. en V. 1860 Deel IX.

29. M. G. Maks. "Reis naar de Kapoeas en Kahajan in de Zuid- en Ooster afdeeling van Borneo." T. v. ind. T. L. en V. 1861 Deel X.

30. "Aardrykskundige aanteekeningen over zuidelyk Borneo." T. v. N. I. 1861.

31.} C. F. Koch. "Omtrent het voorkomen van Platina by Martapoera."
32.} n. T. v. N. I. 1861 XXIII.

33. P. J. Maier. "Scheikundig onderzoek van Platinaerts afkomstig van Martapoera." n. T. v. N. I 1861 XXIII.

34. F. S. Hartman. "Beschryving van eenen togt naar de bovenlanden van Bandjermassin in het jaar 1790 door Leupe." Kronijk van het historisch genootschap te Utrecht. Jaargang XX 1864.

35. J. M. de Jongh. "De Batoe Hapoe in de Zuid- en Oosterafdeeling van Borneo." n. T. v. N. I. 1865 XXVIII.

36. J. W. Schneider. "Onderzoek van Kalksteen uit de nabyheid van Pengaron." n. T. v. N. I. 1865 XXVIII.

37. J. C. Bernelot Moens. "Onderzoek eener aardolie voorkomende in de Z. en O. afdeeling van Borneo tusschen Lampeon en Pringin." Tydschrift voor Nyverheid en Landbouw. 1865.

38. O. F. U. J. Huguenin. "Scheikundig onderzoek van zwart zand en een zwart mineraal van de Zuid-Ostkust van Borneo en Poeloe-Laut." J. v/h. M. in N. I. 1872 II., also in the n. T. v. N. I. 1852 II.

39. G. P. A. Renaud. "Verslag van de Kolenmyn Oranje-Nassau te Pengaron." J. v/h. M. in N. I. 1874 II.

40. R. D. M. Verbeek. "De numulieten uit den eocänen Kalksteen van Borneo." J. v/h. M. in N. I. 1874 II. Also in the N. J. f. Min. u. Geol. 1871.

41. R. D. M. Verbeek. "Geologische beschryving der distrikten riam Kiwa en Kanan in de Zuider- en Osterafdeeling van Borneo." J. v/h. M. in N. I. 1875 I.

42. H. Möhl. "Mikromineralogische Mittheilungen." N. J. f. Min. u. Geol. 1874. (Contains a microscopic description of diabase and bronzite in S. Borneo.)

43. Dr. H. Crétier. "Jets over Pengaron- en Assahankolen en de bruikbaarheid van de eerston voor gasbereiding." J. v/h. M. in N. L. 1880 I. Also in the T. v. N. I. 1881.

44. Carl Bock. "The Headhunters of Borneo, 1881." Also in German: "Unter den Kannibalen Borneo's" and Dutch.
45. P. Van Dyk. "Onderzoek naar de ontginnbaarheid van steenkolen" (pekglanskolen) van de riam Kanan in de Z/O. afdeeling van Borneo. J. v/h. M. v. N. I. 1881 II.
46. W. J. M. Michielsen. "Verslag eener reis door de bovendistrikten der Sampit- en Katinganrivieren in Maart en April." T. v. ind. t. l. en. V. 1882 XXVIII. Also in abstract in "Ausland" 1883 No. 35 and 36.
47. P. van Dyk. "De bevaarbaarheid van de rivier riam Kanan." J. v/h. M. in N. 1883 I.
48. J. H. Menten. "Mededeeling aangaande het vaarwater uit zee langs de Barito en Martapoera rivier." J. v/h. M. in N. I. 1883 I.
49. Th. Posewitz. "Geologische Notizen aus Zentral-Borneo." I. Das tertiäre Hügelland bei Teweh. n. T. v. N. I. 1883 XLIII. und Jahrb. ung. geol. A. 1884.
50. Th. Posewitz. "Geologische Notizen aus Zentral-Borneo." II. Betrachtungen über die recente Bildung von Harzablagerungen. n. T. v. N. I. 1884 XLIV. und im "földtani Közlöny" (deutsch) 1883.
51. Th. Posewitz. "Geologische Notizen aus Zentral-Borneo." III. Das Gestein des Goenong Pararawen. n. T. v. N. I. 1884 XLIV., auch im Jahrb. ung. geol. Anst.
52. F. Grabowsky. "Der Distrikt Dusson Timor in Süd-ost Borneo." Ausland 1884 p. 444.
53. Th. Posewitz. "Geologischer Ausflug in das Tanah-Laut." Verhandl. geol. R. A. 1884 No. 13.
54. Miss Hendrich. "Eine Reise nach Katingan." Bericht der rheinischen Missionsgesellschaft. 1885 No. 12.
55. F. Grabowsky. "Kalksteinhöhlen in Süd-ost Borneo." Globus 1888, Band LIV No. 21.
56. C. M. Kan. "Twee reizigers in de Doesoen." T. aardr. gen. Amst. 1888.
57. E. B. Masthoff. "Aanteekeningen omtrent de onderafdeeling Tabalong en Kaloewa v/d. Z. en O. afdeeling van Borneo." Indishe Gido 1888.

III.—WEST BORNEO = W.

1. Mr. J. H. Tobias. "De Westkust van Borneo." de ned Hermes 1826 III. under the title, Macassar.
2. G. Müller. "Proeve eener geschiedenis van een gedeelte der Westkust van Borneo." Inische Bij p. 179–319, 321–375.
3. E. A. Francis. "Westkust van Borneo in 1832." T. v. N. I. 1842 II 4 Jahrg.
4. "Over de goudgraveryen in de afdeeling Sambas." T. v. N. I. 1847 II. (According to Prof. Veth the author D. J. is van den Dungen Gronovius).
5. "Bydrage tot de kennis der binnenlandsche ryken van het westelyk Borneo." T. v. N. I. 1849 I.

6. "Ijzererts in Sintang." T. v. N. I. 1849 I p. 350.
7. W. H. Muntinghe. "De bevestiging van het nederlandsch gezag op Borneo." T. v. N. I. 1850 II.
8. "Steenkolen uit de binnenlanden van Pontianak." Indisch archief 1850.
9. O. von Kessel. "Statistieke aanteekeningen omtrent het stroomgebied der rivier Kapoeas." Indisch archief 1850 II.
10. H. D. A. Smits. "Rapporten betreffende de Pontianaksche steenkolen welke aan boord van Z. M. stoomadviesvaartuig Tjipannas beproevd zyn." n. T. v. N. I. 1850 I.
11. D. W. C. Baron van Lynden en J. Groll. "Aanteekeningen over de landen van het stroomgebied der Kapoeas." n. T. v. N. I. 1851 II.
12. "Kopererts in Sambas." n. T. v. N. I. 151 II.
13. P. J. Maier. "Onderzoek van Koperzand uit het gebergte Tampi naby de groote Penitirivier in de afdeeling Sambas." n. T. v. N. I. 1852 III.
14. Ida Pfeiffer. "Meine zweite Weltreise 1853."
15. "Voorkomen van steenkolen aan de Kapoeas-rivier in de Westerafdeeling van Borneo." n. T. v. N. I. 1854 IV.
16. H. von Gaffron. "Beschryving van den grooten diamant van Matan op Borneo." n. T. v. N. I. 1854 VI.
17. P. J. Veth. "Westerafdeeling van Borneo." 1854.
18. P. J. Maier. "Ijzererts van Goenong Bessi (W.-Borneo)." n. T. v. N. I. 1854 VI.
19. R. Everwyn. "Voorloopig onderzoek naar Kolen in de landschappen Salimbouw Djonkong en Boenoet in de residentie Westerafdeeling van Borneo." n. T. v. N. I. 1854 VII.
20. R. Everwyn. "Verslag van een onderzoek naar de aangelegenheden der goudgroeven in het landschap Landak." n. T. v. N. I. 1854 VII.
20*a*. "Ijzererts. van Goenong Bessi (W. Borneo)." n. T. v. N. I. VI.
21. R. Everwyn. "Onderzoek naar Kopererts by het Tampigebergte aan de Penitirivier, en verdere reis door een gedeelte der landschappen Mandor en Mampawa." n. T. v. N. I. 1859 IX.
22. R. Everwyn. "Onderzoek naar tinerts in de landsehappen Soekadana, Simpang en Matan en naar Antimoniumerts op de Karimataeilanden." n. T. v. N. I. 1855 IX.
23. Dr. J. H. Croockewit. "Verslag van een reisje naar het landschap Palo en naar Tandjong Datoe." (t. v. ind. T. L. en V. 1855.)
24. Dr. J. H. Croockewit. "Verslag van een tocht naar de Goenong Klam en naar het Peneinggebergte." n. T. v. N. I. 1856 XI.
25. R. Everwyn. "Onderzoek naar tinerts in het landschap Kandawangan." n. T. v. N. I. 1856 XI.
26. J. H. Croockewit. "De zoutbron aan de Spaukrivier, landschap Sintang." n. T. v. N. I. 1857 XII.
27. D. W. Rost von Tonningen. "Scheikundig onderzoek van een mineraalwater afkomstig van het eiland Borneo." n. T. v. N. I. 1857 XII.
28. R. Everwyn. "Westerafdeeling van Borneo." n. T. v. N. I. 1858 XVII.
29. H. von Gaffron. "Minerale bronnen in Sintang." n. T. v. n. I. 1860 XX.

30. A. G. Veltman. "Scheikundig onderzoek van zout en mineraalwater in W. Borneo." n. T. v. N. I. 1860 XX.

31. "Grondverzakking in Spauk, afdeeling Sintang." n. T. v. N. I. 1860 XXI.

32. J. J. Peeters. "Eenige mededeelingen omtrent de diamantgraveryen en de diamantnyverheid in de landschappen Landak en Sanggouw." T. v. N. en L. 1861 II.

33. R. Everwyn. "Onderzoek naar Koperts in het gebied van Mandor in de Westerafdeeling van Borneo." n. T. v. N. I. 1862 XXIV. Dasselbe auch im J. v/h. M. in N. I. 1878 II.

34. "Cornelis Kater's reizen in West-Borneo." T. ind. T. L. en V. 1867 Deel XVI.

35. "Molybdänglans in Borneo." n. T. v. N. I. 1871 XXIII.

36. R. Everwyn. "De groote diamant of 'Danau radjah' van Matan in de Westerafdeeling van Borneo." J. v/h. M. in N. I. 1873 I.

37. R. Everwyn. "Looderts in het landschap Kandawangan." J. v/h. M. N. I. 1874 I.

38. J. F. H. Schultz. "Iets over de diamantmynen te Landak." T. v. N. I. 1877 II.

39. R Everwyn. "Overzicht van de mynbouwkundige onderzoekingen, welke tot nu toe door den dienst van het mynwezen in de Westerafdeeling van Borneo werden verricht." J. v/h. M. in N. I. 1879 I.

40. Dr. H. Crétier. "Vermiljoen uit de omgeving van Congouw in het landschap Boenoet." J. v/h. M. in N. I. 1879 II.

41. F. L. le Roi en G. O. Croes. "Verslag van een onderzoek der lood- en zinkertsafzettingen aan de Kandawanganrivier." J. v/h. M. in N. I. 1880 II.

42. C J. van Schelle. "Verslag over het voorkomen van cinnaber by de rivier Betoeng, zytak der rivier Bojan aan de rivier Kapoeas." J. v/h. M. in N. I. 1880 II.

43. C. J. van Schelle. "De geologische en mynbouwkundige onderzoekingen in de Westerafdeeling van Borneo." J. v/h. M. in N. I. 1880 II.

44. C. J. van Schelle. "Opmerkingen omtrent het winnen van delfstoffen een gedeelte der Westerafdeeling van Borneo." J. v/h. M. in N. I. 1881 I.

45. J. W. C. Gerlach. "Reis naar het meergebied van de Kapoeas in Borneo's Westerafdeeling." Bydragen tot de T. L. en V. v. N. I. 1881.

46. C. J. van Schelle. "Beschryving der chineesche goudmyn Sim-Pi-Toe." Verslag No. 2. J. v/h. M. in N. I. 1882 I.

47. C. J. van Schelle. "Gegevens omtrent de goudproductie in W. B." Verslag No. 3. J. v/h. M. in N. I. 1882 I.

48. C. J. van Schelle. "Voornaamste bepalingen omtrent mynontginning in de Westerafdeeling van Borneo." J. v/h. M. in N. I. 1882 II.

49. C. J. van Schelle. "Onderzoek naar goudaders by Sjoei-Tsiet." Verslag No. 4. J. v/h. M. in N. I. 1883 I.

50. C. J. van Schelle. "Onderzoek naar het voorkomen van goud op den berg Hang-Oei-San." Verslag No. 5. J. v/h. M. in N. I. 1883 I.

51. C. J. van Schelle. "Overzicht van de goudproductie van een gedeelte der residentie Westerafdeeling van Borneo gedurende het jaar 1881." J. v/h. M. in N. I. 1883 I.

52. C. J. van Schelle. "Mededeeling omtrent het voorkomen van enkele ertsen en gedegen metalen in den omtrek van Montrado." J. v/h. M. in N. I. 1883 I.

53. R. Everwyn. "Onderzoek van goudhoudend Kopererts afkomstig ui een ader by Sjoei-Tsiët naby Selinsé in de W. afdeeling van Borneo." J. v/h. M. in N. I. 1883 II.

54. C. J. van Schelle. "Mededeeling omtrent eenige ingezonden ertsen en mineralen van het stroomgebied der boven Kapoeas en Melawi-rivier." J. v/h. M. in N. I. 1883 II.

55. C. J. van Schelle. "Mededeeling omtrent het voorkomen van cinnaber ter Westerafdeeling van Borneo." J. v/h. M. in N. I. 1883 II.

56. C. J. van Schelle. "Het voorkomen van ijzerertsen in het boven-stroomgebied der Sambas-rivier." J. v/h. M. in N. I. 1883 II.

57. C. J. van Schelle. "Beschryving der Kolenafzetting by Napan aan de rivier Bojan in het landschap Boenoet." J. v/h. M. in N. I. 1883 II.

58. C. J. van Schelle. "Rectificatie van de mededeeling betreffende de voornaamste bepalingen in de Westerafdeeling van Borneo." J. v/h. M. in N. I. 1883 II.

59. Dr. H. Crétier. "Metallisch ijzer in eene Kiezellei, afkomstig van parit Kayan stroomgebied der Sikajam." n. T. v. N. I. 1883 Band XLIII.

60. R. D. M. Verbeek. "Over het voorkomen van gesteenten der Kryt-formatie in de residentie W. afd. van Borneo." Verslagen en mededeelingen der K. Akademie van wetenschappen. 1883 Deel XIX.

61. H. B. Geinitz. "Ueber Kreidepetrefacten von West-Borneo. Zeitscrift der deutschen geologischen Gesellschaft." 1883 Band XXXV.

62. C. J. van Schelle. "Onderzoek naar cinnaber en Antimoniumglans in het bovenstroomgebied der Sikajamrivier." Verslag No. 6. J. v/h. M. in N. I. 1884 I.

63. C. J. van Schelle. "Over een onderzoek naar goudaders en stroomgoud in het Skadouw-gebergte. J. v/h. M. in N. I. 1884 II.

64. C. J. van Schelle. "Voorloopige onderzoekingen naar het voorkomen van cinnaber in de W. afd. van Borneo." J. v/h. M. in N. I. 1884 II.

65. P. van Dyk. "Aanteekingen op de mededeeling omtrent het onderzoek van goudhoudend Kopererts van Sjoei-Tsiët naby Seliase." J. v/h. in M. in N. I. 1884 II.

66. C. J. van Schelle. "Mededeeling omtrent de geologisch-mynbouw kundige opneming van een gedeelte van de W. afd. van Borneo." J. v/h. M. in N. I. 1884 II.

67. C. J. van Schelle. "Overzicht van de goudproductie in een gedeelte der W. afd. van Borneo over het jaar 1882." J. v/h. in M. in N. I. 1884 II.

68. C. J. van Schelle. "Alsvoren over het jaar 1883." J. v/h. M. in N. I. 1884 II.

69. C. J. van Schelle. "Onderzoek naar goudaderen by Melassen." Verlag No. 9. J, v/h. M. in N. I. 1885 I.

70. C. J. van Schelle. "Ijzererts van Padjiloe W. afd. van Borneo." J. v/h. M. in N. I. 1885 II.
71. C. J. van Schelle. "Overzicht der goudproductie in de Westerafdeeling van Borneo." J. v/h. M. in N. I. 1885 II.
72. C. J. van Schelle. "Onderzoek naar goudaderen by Sikarim." Verslag No. 10. J. v/h. M. in N. I. 1887 I.
73. Dr. Th. Posewitz. "Lateritvorkommen in West-Borneo." Földtani Közlöny (Geologische Mittheilungen: German) 1888 p. 62; also in n. T. v. N. I. Band XLVIII.
74. C. J. van Schelle. "De Vulkaan Melaboe ter Westerafdeeling van Borneo." J. v/h. M. in N. I. 1886 I.

IV. EAST BORNEO = E.

1. J. Dalton. "Papers on Borneo." Singapore Chronicle 1829-1831.
2. Th. van Capellen. "Berigt aangaande den tocht van Z. M. schoener Egmont naar Berouw op de Oostkust van Borneo in het najaar 1844. Bydragen tot de Kennis der ned. en vreemde Kolonien." 1847 p. 74-101.
3. A. L. Weddik. "Beknopt overzicht van het ryk van Koetei op Borneo." Indisch archief 1849 u. 1850.
4. Dr. Croockewit. "Diamantgronden van Koesan." n. T. v. N. I. 1852 III.
5. C. M. Schwaner. "Historische, geographische en statistieke aanteekeningen betreffende Tanah-Boemboe." T. ind. T. L. en V. 1853 I.
6. H. von Dewall. "Aanteekeningen omtrent de Noord-oostkust van Borneo." T. ind. T. L. en V. 1885 IV.
7. J. Hageman. "Anteekeningen omtrent en gedeelte der Oostkust van Borneo." T. ind. T. L. en V. 1855. IV.
8. J. C. J. Smits. "Diamantputten van Wauwaan in Zuid-Oost-Borneo." n. T. v. N. I. 1855 VIII; dasselbe auch im T. v. N. en L. 1855 II.
9. J. G. A. Gallois. "Korte aanteekeningen gehouden gedurende eene reis langs de Oostkust van Borneo 1850." Bydragen tot de T. L. en V. in N. I. 1856 IV.
10. "Aardbeving te Koetei." n. T. v. N. I. 1865 Band XVI.
11. J. Schouw-Santvoort. "Hoogtemeetingen van eenige bergen in het zuidelyk en oostelyk gedeelte van Borneo." Tydschrift van het aardrykskundig genootschap te Amsterdam 1877.
12. J. van Nieuwkuyk. "Exploitatie door Nederlanders van de Oostkust van Borneo." T. v. N. I. 1882 II.
13. J. H. Hooze. "Onderzoek naar Kolen in de Berau'sche landen ter Oostkust van Borneo." J. v/h. M. in N. I. 1886 II.
14. J. H. Hooze. "Onderzoek naar Kolen in het ryk van Koetei ter Oostkust van Borneo." J. v/h. M. in N. I. 1887 I.

V. NORTH BORNEO = N.

1. Hugh Low. "Sarawak, its Inhabitants and Production, 1848."
2. Thomas Bellot. "On the Discovery of Coal on the island of Labuan." "Quart. Journal of the Geol. Soc. 1848."

3. Robert Burns. Mr. Burns' Travels in the Interior of Borneo Proper, the Kayans of the North-west Coast of Borneo." "Journal of the Indian Archipelago 1849."

4. Gold in Sarawak." "Journal of the Indian Archipelago 1849."

5. "Laboean, Serawak, de Nordoostkust van Borneo en de Sultan van Soeloe." T. v. N. I. 1849 I.

6. "The Barram-river." "Journal of the Indian Archipelago" 1851 vol. v.

7. "J. Motley. "Repport on the Geological Phenomena of the Island of Labuan. "Journal of the Indian Archipelago 1852."

8. Bleekerode. "Antimonium van Borneo." T. v. N. en L. 1855 II.

9. Spenser St. John. "Life in the Forest of the Far East, 1862."

10. Spenser St. John. "Observations on the North-west Coast of Borneo. Physical and Political Geography of the District lying between Gaya Bay and the Tampassuk River." "Journal of the R. Geogr. Soc of London 1862." With map.

11. Frederick Boyle. "Adventures among the Dyaks of Borneo" 1865.

12. O. Beccari. "Cenno di un viaggio a Borneo." "Bolletino della Società Geografica Italiana" 1868.

13. "Bydrage tot de Kennis van Borneo's Noord-oost hoek." T. v. N. I. 1869 I.

14. C. de Crespigny, "On the Rivers Mukah and Oyah in Borneo." "Proceed. R. Geogr. Soc. of London" 1872.

15. C. de Crespigny. "On Northern Borneo." "Proceed. R. Geogr. Soc. of London" 1873.

16. "Mededeeling van den heer A. A. Backer Overbeek over Molybdänerts afkomstig van Sarawak." n. T. v. N. I. 1873 XXXIII.

17. Cora, G. "Contribuzioni geogr. Italiane a Borneo." Cosmos di Guido Cora. 1874 Vol. II.

18. Noël Denison. "Jottings Made During a Tour amongst the Land-Dyaks of Upper Sarawak, 1874."

19. F. Giordano. "Un esplorazione in Borneo." Bolletino della Società Geogr. Italiana, 1874.

20. Giacomo Bove. "Note di un vaggio a Borneo." Cosmos di Guido Cora. 1875-1876 Vol. III.

21. F. Gröder. "Das Antimonvorkommen im Distrikte Serawak auf Nord-Borneo. Quecksilbervorkommen in Serawak. Verhandlungen der k. k. geologischen Reichsanstalt in Wien." 1876 No. 3 und 4. "Dasselbe auch in Oesterreichische Zeitschrift für Berg. und Hüttenwesen." 1876 p. 118.

22. A. H. Everett. "Cave Exploration in Borneo." Athenæum, July, 1877, No. 2594.

23. A. H. Everett. "Notes on the Distribution of Useful Minerals in Sarawak. Journal Straits Branch R. Asiatic Society, July, 1878.

24. A. H. Everett. "Volcanic Phenomena in Borneo." Nature, July, 1878, p. 200. Dasselbe in n. T. v. I. Dr. Crétier: vulkanische verschynselen op Borneo.

25. "Notes sur l'île de Borneo." Revue maritime et coloniale. 1878 No. 2.

26. P. L. Sclater. "The New Maharajahate of Sabah, Borneo." Proceed. R. Geogr. Soc. 1879 No. 2.
27. Wesenberg. "Die Bai von Sandakan auf Borneo." Globus 1879 Band XXXV p. 141.
28. "Report of the Committee Appointed for Exploring Certain Caves in Borneo." "Report of the British Association for the Advancement of Science for 1879."
29. A. H. Everett. "Report on the Exploration of the Caves in Borneo." Proceed. R. Geogr. Soc. 1880 No. 203.
30. G. Busk. "Note on the Collection of Bones from Caves in Borneo." Proceed. of the R. Geogr. Soc. 1880.
30*a*. J. Xanthus. "Borneo szigetén 1870 ben tett utazásaimról. Földtan, Közlöny 1880.
31. Dr. Montano. "La rivière Sagaliud." Bull. Soc. Géogr. de Paris 1880 XX.
32. F. W. Burbidge. "The Gardens of the Sun, a Naturalist's Journey on the Mountains and in the Swamps of Borneo and the Sulu Archipelago" 1880.
33. J. Peltzer. "Borneo." Bull. de la Soc. belge de géographie 1881.
34. William M. Crocker. "Notes on Sarawak and Northern Borneo." Proceed. of the R. Geogr. Soc. 1881 April. Also in Dutch in the T. v. N. 1881.
35. Joseph Hatton. "The New Ceylon, being a sketch of North Borneo of Sabah 1881. (Reviewed in T. v. N. I. 1882).
36. P. S. Gundry. "British North Borneo or Sabah." Contemporary Review. 1882 May.
37. "British North Borneo Company." Nautical Magazine 1882 January.
38. M. Ch. Antoine. "Borneo." Bull. Soc. Géogr. de l'Est. 1882 p. 689-696 und 1883 p. 84-91.
39. W. B. Pryer. "Notes on North-eastern Borneo and the Sulu Islands. Proceed. R. Geogr. Soc. 1883.
40. Franz Ritter von Le Monnier. "Das nördliche Borneo nach dem heutigen Standpunkt unserer Kenntnisse. Mittheilungen der k. k. geograph. Gesellschaft in Wien 1883.
41. Diary of F. Witti. "North Borneo." Singapore 1883.
42. "Witti's Diary kept during an Excursion to the Oil-shales of the Sekuati river, and the subsequent journey overland from Marudu Bay to Papar." Nov. 4 to Dec. 5 1880.
43. "Diary of L. S. von Donop, travelling through North Borneo or New Ceylon." Ceylon Observer 1883.
44. "Die Vogelnesthöhlen von Gomanton auf Nord-Borneo." Globus 1884 Bd. XLVI (aus North-Borneo Herald 1. 3. 1884).
45. E. P. Gueritz. "British North Borneo. Journal of the Straits Branch R. Geogr. Asiatic Soc., December, 1884.
46. Leys. "On the Rivers of Borneo." Reports of consular officers. Blue book. C. 3881. Abstract in the T. van het aardrykskundig genootschap te Amsterdam 1884 p. 27, II. Serie Deel I.
47. J. E. Tennison Woods. "The Borneo Coal-fields." Nature 1885 Band 31.

48. Frank Hatton. "North Borneo. Explorations and Adventures on the Equator 1886."
49. "Handbook of British North Borneo," by Sir Rutherford Alcock 1886.
50. Dr. Th. Posewitz. "Der Kina-balu-See in Borneo." Petermann's geographische Mittheilungen 1887 Heft 8.
51. D. D. Daly. "Explorations in British North Borneo 1883-1887." Proceedings of the R. Geographical Society of London 1888 I.
52. S. E. Tennison Woods. "The Geology of Malaysia, Southern China, etc." Nature 1886.
53. B. V. Maine. "Summary of Explorations in British North Borneo." Proc. R. Geogr. Soc. 1888.
54. Th. Geyler. "Ueber fossile Pflanzen von Labuan." Ur "Vega-Expeditionens Vetenskapliga Jakktagelser." Bd. IV. Stockholm 1887.

CONTENTS.

I—HISTORICAL AND CRITICAL.

II.—GEOLOGICAL.

III.—USEFUL MINERALS.

IV.—MINING OPERATIONS.

ILLUSTRATIONS.

MAPS.

BORNEO:

I.—HISTORICAL AND CRITICAL.

DISCOVERY.

There is still some uucertainty as to the precise time when Borneo was first visited by Europeans. According to some the Portuguese, Lorenzo de Gomez, in the year 1518, was the first to set foot on the island; according to others it was not till 1526 that it was discovered by Don Jorge de Menezes, also a Portuguese, on a voyage to the Molluccas. A third version is that the fleet of the famous Admiral Magellan, who was in the Spanish service, touched on the shores of Borneo in 1521, during his journey round the world. Be this as it may, however, it was North Borneo, or more exactly the State Brunei that was first discovered. From this state, which is more correctly termed Burni, the whole island was named Borneo, and the first-named kingdom for distinction called Borneo proper, Burni or Bruni.[1]

The natives themselves, be they Dyaks or Malays, have no expression in general use for the whole island. They speak of separate states, and only occasionally mention Tanah or Pulu Kalamuntan.[2]

The Dutch did not set foot on the island till 1600.

---

[1] See Veth—W. 17.

[2] Kalamuntan (Malay) = *Cerbera Odallam*, is the name of a pear-like fruit to which the shape of the island is said to bear some resemblance. (G. J. Filet, Plantenkundig woordenboek van Ned. Indië, 1876).

(1) SHORT POLITICAL SKETCH.

I begin by giving a short sketch of the political divisions of the island, as the gradual increase and present position of our geographical and geological information are so closely related to them as to make this necessary.

About two-thirds of the island is under Dutch rule, viz.:—South-east, and West Borneo; while North Borneo is split up into three states—namely, Sarawak, ruled by Rajah Brooke, the Sultanry of Brunei, and Sabah or the territory of the British North Borneo Company. (*See Map* 1).

Dutch Borneo.

This area is divided into two "Residencies"—South-east, and West Borneo, each under the government of a "Resident," who is the first civil officer.[1]

South-east Borneo has an area of 361,653 square kilometres,[2] with a population, in the year 1880, of 645,772, or 2·4 per square kilometre.[3] The capital, Bandjermassin, which is the seat of the Resident, lies on the river Martapura, not far from its confluence with the Barito.

The division embraces the following sub-Residencies:—

South Borneo.

1. Martapura with a Controller in:—
   - Batti-Batti,
   - Pengaron,
   - Rantau.

---

[1] At the end of the forties both Residencies were united under one Governor (Weddik). But a few years later they were again separated, as, in reality, they constitute perfectly separate districts, and only communicate by sea.

[2] H. Balbi's "Erdbeschreibung" II p. 752.

[3] See Bydragen tot de Taal-, Land-en Volkenkunde van Ned. Indië 1883, p. 10 and 12.

2. Amunthai, with a Controller in:—
   Kendangan,
   Barabei,
   Tandjong.
3. Marabahan (Dusson and Dyak country) with a Controller in:—
   Kwala Kapuas,
   Buntok,
   Muara Teweh.
4. Sampit (independent Controller).

EAST BORNEO.

5. Kutei (Samarinda) with a Controller in:—
   Pulu Laut,
   St. Lucia Bay.

The military power consists of one garrison-battalion, with small garrisons in all places in South Borneo where civil officers reside, with the exception of Batti-Batti (Tanah Laut), and Sampit; while East Borneo, which is only indirectly under Dutch rule, possesses no military power.

WEST BORNEO embraces 154,506 square kilometres,[1] with a population of 375,412, in the year 1880, or 2·6 per square kilometre.[2]

For purposes of administration this area is subdivided into the following districts:—

Mampawa, with a Controller.
Landak (Ngabang), with a Controller.
Montrado, with an Assistant-Resident.

Sub-Districts, { Montrado, with a Controller.
Lara and Lumar, Benkajang, with a Controller.

[1] H. Balbi's "Erdbeschreibung," II p. 752.

[2] See Bydragen tot de Taal-, Land- en Volkenkunde van Ned. Indië 1883, p. 10 and 12.

Sambas, with an Assistant-Resident.
Sub-District Pamangkat, with a Controller.
Sungei Kakap, with a Controller.
Tajan, with a Controller
Sintang, with an Assistant-Resident.
Sub-Districts, { Melawi (Nanga Pinoh) / Boven-Kapuas (Smitau) } with a Controller.
Sukadana.

The capital and seat of the Resident is Pontianak, on the river Kapuas, and crossed by the Equator. The military power consists of one garrison-battalion, in part scattered over many stations in the interior.

As already mentioned, the Dutch first appeared in 1600 in Brunei, on the north coast of Borneo; four years later they visited the west coast. In 1608 they built a factory in Sukadana, and penetrated to Sambas. In 1778 these lands were presented to the East India Company, but as early as 1791 the settlements were abandoned.[1]

In 1606 the Dutch visited Bandjermassin, the largest state in South Borneo. After various attempts, a trading station was founded there, chiefly on account of the pepper-trade, but it was deserted again in the year 1669.

During the eighteenth century further attempts were made to obtain a footing, and in 1787 the sovereign jurisdiction of the East India Trading Company was recognised, even by the native chiefs, and the monopoly of the pepper trade given up to them. The income diminished so considerably, however, that in 1809, Bandjermassin was again deserted as a trading station.

When, in the year 1818, after an interval of English rule, the Dutch government annexed the Colonies, a footing was obtained in the south as well as in the west of the island.

---

[1] Radermacher B. 1.

In this way the influence of the government was slowly extended to the kingdom of Bandjermassin. In 1824 the whole kingdom, with the exception of the principalities, which are the most thickly populated parts, was made over to the Indian government; and, after the war in 1859–1863, the once mighty state Bandjermassin was brought to an end, by placing it under the direct dominion of the government. Treaties recognising the Dutch rule were also made, and in 1844, the first civil officer (Von Dewall) was sent to Kutei.

At present the whole of South Borneo, with the exception of Kotaringin, is under the direct dominion of the Dutch; while in West and East Borneo native princes still reign, who, however, are subject to the control of the Indian government.

North Borneo (Sarawak).

Rajah Brooke's kingdom constitutes the western part of North Borneo, and is bounded on the south by West Borneo, on the east by Brunei. It is divided into three "Divisions." The western section extends as far as the river Sadong, and consists of the sub-districts, Lundu, Sarawak proper, and Sadong. The middle consists of the sub-districts, Batang-Lupar, Saribas, and Kalukah, and extends as far as the mouth of the river Rejang. The eastern and largest section, which extends to Brunei, embraces the sub-districts, Mukah and Bintulu.

The "Divisions" are governed by civil officers—"Residents." For the maintenance of order a small military power is distributed among fourteen forts; besides this there are three gunboats.[1] The area of the kingdom is over 40,000 square miles, carrying a population, in 1883, of about 300,000,[2] or

[1] Crocker N. 34 p. 204.

[2] According to communications made by A. H. Everett of Labuan.

3·6 per square kilometer. In 1877 there were only 240,000, and of these:—

Sarawak (proper) had	30,000
Batang-Lupar and Rejang, ...	105,000
Third Division, ...	20,000
In the Interior, ...	90,000 to 100,000

A third of the inhabitants are Malays, two-thirds are Dyaks, and there are 2,000 Chinese.[1]

The income of the state in the year 1883, was £271,000; in 1877, only £40,000.[2]

The chief town is Kuching or Sarawak, twenty-three miles from the coast, and a little above the delta of the river Sarawak. The following stations or forts, where officials live, have been built:—

Bintulu, at the mouth of the river Bintulu.

Kabong, at the mouth of the river Kalakah.

Mukah, at the mouth of the river Mukah.

Matu, on the river Matu, five miles from the coast.

Oya, one and a-half miles up the river Oya.

Rejang village, at the mouth of the river Rejang.

Simunjan, on the river Sadong, eighteen miles from the coast.

Saribas, on the river Saribas, eighty miles from the coast.

Siba, on the river Rejang, sixty miles from the coast.

Tatau, on the river Tatau.

Simanggang, on the river Batang-Lupar, sixty miles from the coast.

Claude Town, on the river Barram, sixty miles from the coast.

A station, twenty-two miles from the coast, on the river Trusan.

---

[1] Le Monnier N. 40 p. 479.

[2] According to A. H. Everett.

Originally Sarawak belonged to the Sultanry of Brunei, and it has only formed an independent kingdom since 1841, its first ruler and founder was an Englishman, Sir James Brooke.

This remarkable man was born in 1803, and entered the Anglo-Indian service as cadet, but had to go to Europe in consequence of a wound. When he returned to India, he was soon obliged to go to China on account of failing health. On the way he became acquainted with the Malay islands, commenced studying them, and formed the design of putting down the slave trade then flourishing there, of extirpating piracy, and of civilising the natives. It was not until 1838 that he could carry out these plans. In that year he went with a small war-ship to North Borneo, where at that time there was an insurrection in Sarawak. For his services in helping the suzerain, Rajah Mudah Hassin, in restoring order, he was rewarded with Sarawak, in 1841.[1]

Brooke introduced order and method into his country. On his death he was succeeded by his nephew, Charles Johnson Brooke.

The boundaries of Sarawak were considerably extended in the course of years. As already mentioned, the land between Cape Datu and the river Samarahan was ceded to Sir James Brooke by the Sultan of Brunei. In 1861 he obtained all the rivers and the lands appertaining thereto, to the east as far as Point Kadurong. In 1882 more lands, extending to the river Barram, were added, and the boundary drawn at a distance of three miles from the right bank. By these means Sarawak was increased by about one hundred miles of coast line. After 1883, the land drained by the river Trusan was acquired. This district lies to the north of the river Brunei, and is separated from the territory of the British North Borneo

---

[1] For the supposed cause of the insurrection see under "Occurrence of the Antimony Ores." Ida Pfeiffer I. p. 54 ; Veth W. 17 II ; Le Monnier N. 40 p. 448.

Company by the small rivers Lawas and Mengalong. Further extensions are being contemplated at the present time.[1]

The Island of Labuan.

This island, belonging to Borneo, and situated at the entrance to the Bay of Brunei, constitutes an English colony. The colony is under the rule of a governor, and, in addition to Labuan (which is 16 kilometres long and 8 kilometres broad), comprises the smaller islands, Kuraman, Burong, Rusukan besar and Ketjil, Enoe, Pappan, and Daat.[2]

Labuan, important as a coaling and intermediate station for steamers travelling between Singapore and China, came into the English possession in 1846. The Sultan of Brunei was punished for taking part in piracy, and under the arbitration of J. Brooke had to make over the island to the English crown.[3]

Sabah.

North-eastern Borneo, which is in possession of the British North Borneo Company, under English protection, comprises an area of 23,000 square miles (= 1,323 square geographical miles, = 72,765 kilometres). It is provided with excellent harbours, in fact the only good harbours and bays in the whole of Borneo. On the south-west it is bounded by Brunei, and on the south by Dutch Borneo. For purposes of administration it is subdivided into four provinces, viz.:—Keppel, Dent, Alcock, and East-coast.[4]

The chief town is Elopura, founded in 1879, in the Bay of Sandakan. The residences of the civil officers are all situ-

---

[1] Communicated by A. H. Everett of Labuan.

[2] Le Monnier N. 40 p. 480 and 520.

[3] Van der Lith. Nederlandsch Oost-Indië p. 273.

[4] Mr. W. Crocker, the Manager of the British N. Borneo Co., informs me that the territory of the Company is now divided into nine provinces, namely:—Alcock, Cunliffe, Dent, Dewhurst, Elphinstone, Keppel, Martin, Mayne, and Myburgh. The administration of the Island of Labuan has also been entrusted to the Company by the government.—*Translator.*

ated on or near the coast. The stations are: Kimanis, Papar, Gaya, Putatan, on the west coast; Kudat on the north, in the Bay of Marudu; and Silam and Balmoral on the east coast.[1] The government is administered by a governor, assisted by a council.

This territory formerly belonged to the Sultans of Sulu and Brunei, who both laid claim to it. According to the claim of the Sultan of Brunei, the whole neighbourhood of Brunei, as far as the river Sibuko in the east, belonged to him; while the Sultan of Sulu maintained that the whole country, from the river Sibuko in the east, as far as the river Kimanis in the west, was a part of his kingdom. As early as 1763, Dalrymple, who was in the service of the East India Trading Company, had acquired a large portion of North Borneo for commercial purposes (river Kimanis in the east to the river Kaniongan in the west), but little value was attached to its possession by the Company.[2]

In 1865 the American consul in Brunei obtained three concessions of territory from the Sultan of Brunei, and made over his rights to the American Trading Company of Borneo, who, however, soon relinquished their intention. Baron Overbeck, then Austrian Consul-General in Hongkong, obtained all the rights from Torrey, the only surviving member of the Company. Overbeck cherished the idea of founding a colony there. He tried in 1873 and 1876 to win over the Austrian government and Vienna capitalists to his views, but in vain. In London, however, he succeeded in securing A. Dent's financial assistance, and they obtained, on the 20th December, 1877, the cession of the north-eastern portion of Borneo. The Sultan of Brunei made Baron Overbeck governor of these districts, with the title of Maharajah of Sabah,

---

[1] Mr. Crocker informs me that the stations are now Menpakol, Papar, and Gaya, on the W. coast; Kudat in the N.; and, on the E. coast, Sandakan, Silam, and Simporna.—*Translator.*

[2] Crocker N. 34 p. 206. Veth W. 17 Introduction.

and Rajah of Gaya and Sandakan, with sovereign rights. For this service the Sultan received a yearly payment of 15,000 dollars. But since, as shown above, the Sultan of Sulu also laid claim to the same districts; Baron Overbeck and A. Dent obtained other concessions from him in 1878. The Sultan of Sulu received annually 5,000 dollars, and made Overbeck sovereign-governor, with the title Datu Bandahara, and Rajah of Sandakan. Spain, however, refused to recognise these concessions, it being her intention to assume the sovereignty over these lands herself, on the plea that in the war between this power and Sulu, in 1876, the latter had recognised the protection of Spain. Towards the end of 1879 the Governor of the Philippines sent a war-ship to demand the withdrawal of the new flag, but this design was met by a protest on the part of the English Consul-General of Borneo residing in Labuan.

Soon after these territorial concessions, Dent acquired all Overbeck's rights for himself, and founded in 1881, the "British North Borneo Company," of which the territory extended from the river Sibuco in the east, to the river Kimanis in the west. The rights thus obtained were formally recognised on 1st November, 1881, by the English government, whereby the company was protected from foreign claims, and obtained more credit in the eyes of the natives.[1]

In 1885, the the company enlarged its territory by one hundred miles, from the river Kimanis to the river Sipitong, purchasing three districts from the Sultan of Brunei.[2]

SULTANRY OF BRUNEI.

Up to about fifty years ago the whole of North Borneo, from Cape Datu in the west to the River Sibuco in the east,

---

[1] There still exist differences with the Dutch government with respect to the southern boundary, as the latter State wishes to have the boundary carried as far north as the Bay of St. Lucia.

[2] See Le Monnier N. 40; Sclater N. 26; Antoine N. 25, 36, 37, 38.

belonged to the Kingdom of Brunei. In the course of years, however, this mighty Malay State has decreased by continual concessions of territory.

First the land extending from Cape Datu to the river Samarahan was, as already mentioned, handed over in 1841 to Sir James Brooke. This was followed by further concessions in 1861–1862 and in the last few years, whereby the western boundary was in each case shifted further eastwards. These continual alterations of the boundary can be seen, for instance, in the maps of Crocker and F. Hatton.

In 1846 the island of Labuan was handed over to England. In 1877 and 1878 the contract with the British North Borneo Company was made, by which the whole of the land from the river Sibuco, in the east, to the river Kimanis, in the west, was ceded. In 1885 the western boundary was moved to the river Sipitong.

At the present time the Sultanry has dwindled down to the basin of the river Brunei and that of the little rivers Lawas and Mengalong. Some small patches of land in the Bay of Gaya also belong to the Sultan, but these are about to be bought by the British North Borneo Company. Most probably the remaining river-basins will, before long, be incorporated with Sarawak, whereby a once so importaut state will have ceased to exist.

The chief town of the Kingdom of Brunei holds the same name on Brunei Bay, at the mouth of the river Brunei.

---

(2) GEOLOGY.[1]

The geological information of the different parts of Borneo at present available is intimately connected, as already pointed out, with the political divisions and relations of the island. This statement may appear strange to those un-

[1] Map 1.

acquainted with colonial affairs. Those, however, who have lived in the Colonies, or, at least, are acquainted with colonial matters, will find it well founded and natural. For it is only in those parts where a foreign conquering power has obtained a firm hold that the ground can be examined, and the results of examination utilised. In districts where European influence was little felt, or only nominally existed, no extended investigation could be even thought of, and only in exceptional instances did a traveller, bolder than the rest, dare to traverse them.

Seen from this point of view, the geology of Borneo is found to be in various stages of development. There are some districts that are still entirely unknown; some, of which we only possess isolated notices; and only a few of which we know the geological structure with any degree of certainty.

Another circumstance to note in the same connection is that geological investigations in this island have always had a purely practical end in view. In the search for profit, the country was prospected for gold, diamonds, and coal, and details as to the special geological relations were only accumulated as subsidiary matters. In this way various fragments of geological information have been obtained; and it is only in the last few years that, in addition to practical results, attention has been directed to purely geological relations. Let us look more nearly into the matter.

In SOUTH BORNEO the south-east point has been examined in detail. In its neighbourhood—in Bandjermassin—are the chief settlements of the Dutch, and, on the other hand, it is just these districts—Tanah-Laut—that have been renowned from time immemorial on account of their gold and diamond fields; the first coal mine in Pengaron is also not far removed from this place. It is not to be wondered at, therefore, that these districts have been carefully examined in regard to their geological and mining relations; for, on the one hand, locomotion was safe, and on the other, profitable practical results were to be expected. But these districts are the only ones that have undergone exact investigation. Of the interior and the western river basins we possess, with the exception of a few details, only general information, the main features of the geological structure alone having been disclosed. This is partly due to an absence of safety in districts so far removed, European influence being there but slightly felt, but partly also to a lack of enterprise and of thirst for information. Further, there were political motives; for it was not considered advisable to prosecute researches in districts where there was not sufficient protection, since differences with the natives might thereby result, to allay which would require a vigorous application of political power. This, however, was exactly what they wished to avoid.

In West Borneo we meet with the same conditions as in the south of the island. Not far from Pontianak—the chief settlement in the west—are the famous "Chinese districts," celebrated on account of their richness in diamonds and gold. These were the chief fields for mining enterprise and, consequently, have also become well known. The remaining districts have been traversed in the search for coal and other useful minerals, by which means we have gained a slight knowledge of their geological structure. And, here again, it is only isolated spots where special prospecting researches have been carried out that have been more closely examined The land in the interior, the districts in the neighbourhood of Central Borneo, are almost entirely unknown, no one having supplied any information about them.[1]

Of East Borneo we possess relatively the smallest amount of information. But it is here, too, that the Dutch rule is least developed. Here also the few details of geological structure that have been made known, were obtained solely

[1] With the exception of G. Müller, whose notes were lost on his murder. Sec page 22.

through practical motives, prospecting for coal, etc. The southern lands—Kusan, Tanah-Bumbu, Passir—have been described in general terms by scientific travellers; while of the northern districts (north of Kutei), with the exception of a few places, our knowledge is greatly deficient. But for a few vague notices, these parts of Borneo, and especially those lying more towards the interior, would be a *terra incognita.* European rule is only nominal here, and travellers have not yet dared to penetrate in this direction.

Our information about North Borneo is also still very deficient. In Sarawak no important geological researches have been made. We possess general information with regard to the occurrence of minerals, but only in respect to a few localities are special details known. Little has been done towards determining geological relations. As to the Sultanry of Brunei, we have only the results obtained by an intrepid traveller in the thirties. The remainder is still a *terra incognita.* Up to the year 1880 it was the same with the north-easterly point of Borneo, the present Sabah, or territory of the English Trading Company, who, about this time, gained a footing here. In this short period, however, much has been done, although at present, only in a geographical direction—for it is in the nature of things that geographical should precede geological information. Courageous travellers have traversed these regions, till then completely unkown, and have largely increased our knowledge: the topographical maps have undergone considerable alterations, and still continue to change: even in regard to geology, sufficient has been done to disclose the chief features of the geological structure of the country. If this method of procedure be persevered in, in a short time that part of Borneo, which up to the present has been least known, will become the one that has undergone closest examination—to the credit of the English Trading Company be it said.

(3) DISCOVERIES, TRAVELS, AND GEOLOGICAL INVESTIGATIONS.

In the following pages I have endeavoured to give a short sketch of the scientific travels, etc.. The history of these is divided in the Dutch territory into those of—South, East, and West, Borneo, and those of the northern part of the island. These must therefore be treated separately.

DUTCH BORNEO.

In Dutch Borneo the explorations made under the Government of the East India Company, up to its extinction in the beginning of the present century, must be distinguished from those which, since 1814, have been made under the direct rule of the Dutch. In the latter there are three periods to consider—First, from 1814 up to 1850; secondly, the earliest period of activity on the part of the Indian mining engineers; and, thirdly, their second period of activity in the eighties.

Scientific Work under the East India Company (1602–1796).

This great company, which for nearly two centuries ruled supreme, has left behind but few scientific traces. But its name alone signifies the object of its rule in the East Indies. Its trading spirit could not allow any explorations to be made that were not absolutely necessary in its own interests.

Thus, they mapped-in the coast lines along which they sailed, but as they never ventured far into the island but traded solely on the coast, the interior always remained a *terra incognita*. The company knew its own interests too well; and had it been possible to further these by explorations, they would undoubtedly have undertaken them. But when quarrels arose with the natives that had to be settled by military force, and thus caused them to venture a little further inland; or when a merchant was compelled by the cessation of business relations to leave the coast for a while and travel into the interior: then only was any news to be had of the country and character of the people of the interior.

The company always viewed all explorations made in these unknown regions with suspicion and doubt. Their trading policy demanded secrecy. To travel into the interior was regarded as equal to desertion, and was forbidden under pain of the severest penalties. To prepare maps and charts was considered a crime, and was treated as theft or robbery. Under such circumstances, therefore, it was impossible to explore the country to any useful extent. Even if, here and there, the interior was visited by means of the rivers, there was generally a lack of interest and of the knowledge necessary to lend to the descriptions the character of scientific explorations.[1]

Thus it was that very little was known regarding Borneo and the surrounding islands, and that the most extravagant and fabulous tales were in circulation.

This want of knowledge is illustrated by the maps themselves, which were nothing better than the roughest sketches, and represented only portions of the coast. This is very plainly shown in the atlas of twelve sheets published by Bosch in 1818.[2] What ideas were then current with regard to Borneo is seen in what he himself says:— "Its size prevented Europeans from penetrating to the interior, and the unhealthy climate drove them from the coast. Central Borneo was supposed to be a large, unhealthy

[1] Dr. Kan B. 47.

[2] To be mentioned also is one of the oldest maps of the Malay Archipelago—"Mare indicum," a fragment of Diego Ribeiro's Map of the World (1529),—on which only the northern coast of Borneo is shown. See S. A. Tiele: de oudste Kaarten van den maleischen archipel. (Bydragen tot de Taal-, Land- en Volkenkunde van Ned. Indië) 1883.

plain, flooded during the rainy season, and the Kapuas and other rivers were believed to have their sources in a large lake in the interior of the island. Others, again, thought that a chain of mountains, called the Crystal Mountains, ran through the island from north to south, and that it was much subject to earthquakes and volcanic eruptions."[1] And yet, curiously enough, it was under the government of the East India Company that explorations on a great scale first took place in South Borneo, namely, in the district of the river Barito, through which a true idea of the topographical relations of the country was obtained.

The knowledge of this discovery remained unknown until seventy-five years after the publication of the MSS., when it was found among the colonial archives, and was published in one of the Dutch historical periodicals. A striking proof of this is the fact that Professor Veth, so well known on account of his Dutch Indian History, knew, until quite recently, nothing of these discoveries.[2]

When, in 1787, the Sultan of Bandjermassin leased his territory to the East India Company, it was decided to ascertain what advantages could be derived from it, and for this purpose F. J. Hartmann, a sergeant of the company, was commissioned, in 1790, to explore the country, and to investigate its resources and general condition.

To this end Hartmann undertook three journeys. During the first he travelled along the foot of the Meratus Mountains. From Martapura he travelled along the rivers Riam Kanan and Riam Kiwa, until he reached the districts Margasari, Amandib, Negara, Amunthai, Kaluwa, and Tabalong, returning by way of Marabahan to Bandjermassin.

On the second journey he went up the river Barito as far as Muara Teweh, and explored the latter together with its tributary Benangin for a few days' journey, until he reached the boundary of the territory of Passir, which is only one

[1] De Seyff B. 8. [2] F. J. Hartmann S. 34.

day's journey further. Returning to Muara Teweh, he travelled a day's journey up the river Barito as far as Majang, but was compelled against his will to return, as unfriendly tribes were in possession of the Murong-Siang district, which he wished to explore.

Hartmann also navigated all the tributaries of the Barito, as well as the S. Montallat, the upper portion of which flows through a mountainous region. This he explored during two days' journey, as far as the last inhabited place. He also travelled up the S. Ayu for four days, until he came to a cataract. In the basins of both these last named rivers he found many coral-reefs. Finally, he visited the rivers Limu, Siong, Karrau, Mengkatip, and Pattai. After an absence of more than three months he returned to Bandjermassin.

Soon after he had been advanced, in recognition of his valuable services, he was surprised near Mantallat, during a third journey through the Barito district, in 1792, and murdered by two Dyak chiefs.

The observations of Hartmann are, generally speaking, correct, as has been proved by comparison. He developed in rough outline a true picture of the basin of the river Barito, mentions the coral-reefs in the different rivers, also the occurrence of gold and iron, and describes for the first time the process of smelting iron in use with the natives.

Scientific Travels from the beginning of the present century up to about 1850.

The history of Dutch discoveries does not begin until about 1818.

We meet in this period with a great number of men who, partly encouraged by government, and partly impelled by their thirst for knowledge, tried to illumine that which up to their time had remained obscure. It seemed as if they were anxious to expiate all the errors committed during the government of the East India Company, and to show that the inclination for nobler undertakings was not yet quite extinguished. And in this noble rivalry of discovery we meet with many German names. Indeed, one might almost assert that the greater portion of the scientific, more especially the topographico-geological, work done, particularly in South Borneo, is attributable to German travellers in the service of the India Company.[1]

Of all the bold and courageous travellers and explorers the greatest praise belongs to those who not only penetrated to the interior, but who also traversed the mountain-chains, and crossed the island in various directions.

Travels between 1820 *and* 1830.

The first travels in the twenties were undertaken in West Borneo. In this connection we meet with the names Tobias, Hartmann, Von den Dungen Gronovius, and G. Müller. With the exception of the latter, they were all administrative officers, who undertook various official journeys, in order to spread and consolidate the influence of the Indian government.

In this way Mr. J. H. Tobias,[2] formerly Resident of Bantam

---

[1] Dr. Kan B. 48, p. 48, also mentions the increase in our information, "*le plus souvent, hélas, grâce à l'initiative étrangère;*" and adds that Dutchmen, such as Halewyn, Hartmann, Von den Dungen Gronovius, undertook, as early as the years 1822–1828 (much earlier, therefore, than S. Müller and Schwaner), dangerous and, for these times, courageous journeys far into the interior of Borneo; and that in Borneo, as elsewhere in the history of explorations, those who cross the Continent do it on the shoulders of their predecessors. To this I must remark, that in West Borneo George Müller (a German) undertook a journey in the same years, and far surpassed his contempories, Hartmann, Tobias, V. d. Dungen Gronovius; further, that Halewyn only reached Marabahan, on the river Barito, and, consequently, his travels were not of much use to the later explorations of Henrici, S. Müller, Horner, Schwaner, etc. There is no doubt that much useful information was obtained from those journeys; but the investigations of the above-mentioned Germans considerably surpassed them.

[2] For Works see S. 1, W. 1, and other unpublished writings.

in Java, came on a government mission to West Borneo, and was the first European to travel on the river Kapuas, up which he went as far as Sintang. The knowledge obtained by him of the west coast exceeded in extent and exactitude everything which up to that time was known of that part of Borneo. Tobias also had topographical maps prepared. In 1823 he was sent on a similar official errand to Bandjermassin (South Borneo).[1]

L. C. Hartmann,[2] formerly officer in the artillery, came, as early as 1818, to West Borneo as first official from Pontianak. In 1823 he undertook a journey up the Kapuas, and discovered the Danau district on the Sarawak boundary. On the river Kapuas he reached the river Djonkong. On a second journey he reached Merenkiang, on the river Sikajam, and navigated also the river Melawis as far as its confluence with the Batang Kajan. In 1826 he was appointed Resident of West Borneo, and in the following year came to Bandjermassin in a similar capacity.[3]

D. J. von den Dungen Gronovius[4] came in 1822 to Landak, where, among other things, he made a topographical sketch map of the country. In the same year he travelled along the river Kapuas as far as Sintang. In 1825 he became Resident of West Borneo; he was, however, removed, but returned again as Resident between 1827-1831.

Associated in the work with these men in West Borneo between 1818–1824, was George Müller; we have chiefly to thank him for our topographical and historical knowledge of that part of the island. With regard to his travels in West Borneo, he overtowers by far the contemporaries already alluded to.[5]

George Müller was a German from the Rhine provinces,

---

[1] See Veth W. 17 II p. 33, 114, 347, 354, 356, 438.

[2] Works not published, but mentioned, by Veth, W. 17.

[3] For Works see Veth W. 17 II p. 33, 114, 347, 354, 356, 438.

[4] For Works see W. 5.

[5] For Works see G. Müller W. 2; also E. Müller B. 2; and in Veth W. 17.

being born at Mayence in 1770, and having enjoyed a scientific education. He was for a time an officer in the Engineer corps of the Austrian army, but later on he entered the French service, and became a warm adherent of Napoleon I. After Napoleon's fall he entered the Dutch-Indian army as Captain, and went to India in 1817. He soon retired, however, from military service, in consequence of unjust treatment, as he considered, and then entered the Civil Service.

As Deputy-Resident he went in 1818 to Sambas, in West Borneo, from which post he was released a year later, as, according to his superiors, he did not evince sufficient tact. He was appointed Inspector of the nutmeg and spice plantations on the island of Banda in 1820. Two years later (1822) he returned to West Borneo as Inspector of the Interior Provinces. He was required among other things to make as many topographical surveys as possible, and also to map accurately the principal rivers.

One of his first duties was to travel into the territory of the Kajans, a race of people living in the interior of the island, on the upper courses of the Redjang, the Kapuas, etc. However, on account of political reasons, he first visited the southern provinces of Simpang, Matan, Sukadana, and did not set out on his journey to the north coast of Borneo before the following year, during which he mapped the west coast from Sambas up to Cape Datu. He reached the mouth of the river Redjang in safety, but was there received with such hostility by a party of the inhabitants, that, not feeling himself sufficiently strong to force his way through, he had to return to West Borneo.

In 1824 he tried to reach the territory of the Kajans, by way of the river Kapuas. On the journey he made topographical sketch-maps, went up the river Tawang, the right tributary of the Kapuas, thus reaching and mapping-out the lake district discovered by Hartmann in 1823.

Then he followed up its course as far as its confluence with the Sibau, where he was the first European to meet with the Kajans. At this point he was forced to return; but formed the project of crossing the island, and of forcing his way through to Bandjermassin in the south.

Having reached Pontianak, he shortly undertook his second journey on the river Kapuas, and reached the Sungei Atong, a tributary stream, which is in 113° 15′ east longitude, where the rocks in the bed of the river hindered his further progress. He was therefore compelled to return, unable to carry out the object of his journey.

In 1824 he travelled to Batavia, where he fell ill, and could not find time to work out his notes[1] before he was sent out in the next year (1825), on another mission to Kutei, on the east coast. On the way he mapped-in the east coast of Borneo as far as Kutei, and made a political contract with the Sultan. He then prepared for his second journey: to cross Borneo from east to west.

With an escort of twelve Javanese soldiers, he travelled up the river Mahakkam. Above Long-Merah he followed the tributary Long-Haweng, a river which leads, within a few days' journey, to the mountains forming the divide between East and West Borneo. At Puran-lalan, which is the last inhabited place on the river, he had to begin his journey on land. This lasted eight days, before he reached a navigable river, belonging to the basin of the Kapuas. Only a few hours' journey separated him from the place which he had formerly reached, and Sintang was not far off, where he would have been in perfect safety. But this was not to be. The boats were all ready, and Müller was preparing to start, when he was treacherously struck down by some newly-arrived natives, and killed (1824). His escort was also murdered, with the exception of one of the soldiers, who succeeded in escaping, and, after much suffering and priva-

[1] In this he mentions the fate of Horner, Schwaner, Henrici, and Gaffron.

tion reached Pontianak, where he substantiated the fact of Müller's death, about which rumours were already afloat.

Thus ended the career of this brave pioneer of science, whose death has unhappily not yet been revenged. His notes were all lost, and could not be recovered, although a few years later search was made for them by Schwaner and Dalton.

In South Borneo, the first great journeys were undertaken by M. H. Halewyn[1] in the years 1824 and 1825. He acted there as Governor-General. Traversing Tanah-Laut (Tabanio, Pleihari, Sungei, Runti), he travelled along the river Barito as far as Bekompai (Marabahan), and also navigated the little river Dajak (Kapuas). In 1824 he reached Kottaringin.[2]

In East Borneo it was an Englishman named John Dalton[3] who first travelled from Singapore to Kutei, namely, in 1827. He sailed in a small boat along the south coast of Borneo as far as the territory of Pagattan, and after staying there for some length of time, he resumed his journey along the east coast to Kutei.

In this district he remained eleven months, travelling up the river Mahakkam as far as Kotta and Marpu, where he made enquiries concerning G. Müller's death. After remaining there fifteen months he returned to Singapore.[4]

Travels from 1830 *to* 1840.

In West Borneo, between the years 1830 and 1840, we only meet with one name, Henrici; while in the south of the island we have not alone his, but also that of Horner, S. Müller, and Korthals.

A. H. Henrici,[5] a German, or German Swiss, arrived in

---

[1] For Works see S. 4. [2] For Works see E. 1.

[3] See Veth Borneo I : Inleiding p. lx. [4] See Veth Borneo I p. lxiv.

[5] S. 30, p. 65 and 267 ; further, S. Müller S. 22, p. 198 and 233 ; further, Weddik E. 3, and Dr. C. M. Kan B. 48, p. 47. C. B. H. von Rosenberg : "Der Malayische Archipel." preface p. viii. ; Van Lynden W. 11.

West Borneo in 1830, in which Residency topographical researches had ceased since the death of G. Müller. His first commission was to make a topographical survey of the Chinese districts, which territory he traversed in all directions. He also navigated the Kapuas, made collections, and drew up a large map of West Borneo, consisting of sixteen pages, with special reference to its topographical and physical geography.

In 1832 he returned to Java, but was wrecked on the coast of Borneo, by which all the memoranda of his travels and his collections were lost, his topographical map alone being saved.

A year later he came to South Borneo as military Governor, and here navigated the Barito as far as the tributary Bumban, thence continuing his journey on foot to the next tributary, Boboat. He passed three villages, and arrived at Lawangminka, the farthest point (in the Barito basin) in Central Borneo ever reached by a European up to quite recent times. He also followed the large tributary, Teweh, on the left side, farther than S. Müller and Korthals, who came after him. In the same way he followed the river Negara and its tributary, Pattai. On the river Negara, and still further on the river Tabalong he reached Muara Sentau, which is situated close to the mountains dividing South from West Borneo. He also explored the Kapuas, and must also be thanked for scientific information of the Kahajan, which he is said to have visited in 1834. Unfortunately he could not himself work out his notes, as he succumbed to an illness shortly after his return to Europe in 1836; they are, however, made use of in the account of his successor, S. Müller.

Henrici's worthy successors in South Borneo were the members of the Natural History Commission:[1] S. Müller,[2]

[1] In the year 1820 a scientific institution was established in Batavia—the Natural History Commission,—the members of which were scientific men, and whose glorious duty it was to explore the as yet almost unknown island. The members of this Commission were—Salomon Müller (Zoologist), Horner (Geologist), and Korthals (Botanist); further, Schwaner and Croockewit.

[2] S. Müller S. 22.

Horner,[1] and Korthals. Their travels lasted four and a half months, and extended over a part of the Barito territory, and over that of the Tanah Laut.

Following the Barito up-stream, they reached the left tributary, Teweh, together. Here the companions parted, and while Horner continued on the Barito, S. Müller and Korthals travelled for some distance on the Teweh. Horner reached the river Bumban, left tributary of the Barito, and arrived at Tabelien; not so far as Henrici, who had pushed forward to the tributary Boboat.

S. Müller[2] and Korthals, on the Teweh, reached Pilas, a place on the Sungei-Benangin, a tributary situated near the divide.[3]

A second journey was undertaken in Tanah-Laut as far as Tabanio, a place on the coast, where the rich gold and diamond fields were visited. Horner published his researches in a preliminary report to the Indian Government. But unfortunately he was not permitted to elaborate them, for as early as 1839 death overtook him in Padang, during his travels in the highlands of Sumatra.

Travels from 1840 *to* 1850.

S. Müller's and Horner's investigations in South Borneo were continued by Dr. C. H. L. M. Schwaner.[4]

Schwaner occupies undoubtedly the first place among the explorers of Borneo, and we shall certainly not be very wrong if we call him the scientific discoverer of Borneo, since he was the first who published a work on Dutch Borneo which was excellent in every respect, and has not been equalled since.

He was born at Mannheim in 1817, and after ending his studies in Germany was appointed by the Dutch Government

---

[1] L. Horner S. 2.

[2] S. Müller also gives scientific notes on the Kahajan. (See S. 27, p. 267.)

[3] See Verbeek S. 41, p. 22; K. Martin, B. 39, p. 283; Von Rosenberg: "Der Malayische Archipel." 1879, preface, p. 8.

[4] S. 9, 13, 16, 21, E. 5. His chief work is "Borneo."

in 1841, a member of the Natural History Commission for India. On reaching Java, he was instructed to cross the island of Borneo, then almost entirely unknown, in different directions, and to collect information with regard to its natural wealth. This task he solved in a most brilliant manner.

In Geography and Geology (for he was principally a Geologist) he made important discoveries, and wrote besides on the inhabitants, their manners, and customs, laying great stress upon their trading and commercial systems. His memorable explorations lasted from 1844-1847, through a part of which Von Gaffron was his travelling companion.

In 1847 he left Borneo, in order to work out his reports in Java. At the end of 1850 he received another commission from the Indian Government to pursue his scientific travels in the southern states of East Borneo, but he was unable to carry out his plans, as he died in Batavia, a few months later, from a very severe attack of fever. Had he not come to such an untimely end, he would in all probability have played the same part in Dutch Borneo as Junghuhn did in Java. It remained, however, unhappily but a brilliant beginning.

The real monument to the memory of this untiring man is his celebrated work, entitled, "Borneo," and as often as scientific works are mentioned in connection with this island, will his name be spoken of with the profoundest respect.

We pass on now to his travels.[1] These extended over Tanah-Laut, along the east coast as far as Passir, the basins of the Barito, and a part of the Mahakkam; further, the basins of the rivers Kapuas, Kahajan, Katingan, Melahui, and Kapuas-Murung, to the westward.

In Tanah-Laut he examined the gold and diamond fields,

[1] Schwaner's fate was the same as Horner's: he also died before his works could be published, and they were edited by others. Thus, "Borneo," by J. Pynaffel; S. 13, by Croockewit; and S. 21, by an un-named editor.

as did Horner. His chief service was, however, the finding of workable coal beds, near the river Riam Kanan, or Sungei Batu Api (=Flint river), near Lokpinong, about twenty-four kilometres up the river, in the neighbourhood of the Gunong Batu Bobaris, the mountains forming the divide between the rivers Riam Kanan and Riam Kiwa, in Pengaron. With regard to Tanah Bumbu, on the east coast, he visited Klumpang bay, Pamukan bay, and the chief place, Passir,[1] he supplied historical, geographical, and statistical notes, which are, even at the present day, of actual interest.[2]

He navigated the Barito as far as its tributary the Teweh, and travelled up this to the divide between South and East Borneo, over which he passed, so reaching the basin of the river Mahakkam along the rivers Lawah, Bundung, and Pahu (or Pahit), the last-named of which is its tributary.

On the river Bundung, Schwaner met with Dewall, the then energetic Civil Officer in charge of Kutei, and travelled in his company as far as Muara Pahu, on the river Mahakkam, then passing along it toward the interior as far as Long Merah, 1½° north latitude.[3] From here they returned to the river Rattah, and while Dewall returned to Samarinda (Kutei), Schwaner attempted once more to cross the divide between South and East Borneo, this time, however, 1° further north. Travelling up the river Njerobungan, he pressed forward into the basin of the Marui, this river being a tributary of the Sungei Laung, and following its course, he finally reached the River Barito, and the capital, Bandjermassin.

Schwaner had thus crossed, at two different points, the water-shed which separates South and East Borneo, and had also traversed much of the interior of Kutei.[4]

His best, but at the same time most difficult journey now

---

[1] He surveyed the river Kendilo-Passir as far as Peraga. (See E. 3.) [2] E. 5.
[3] E. 3. [4] On his map there are two sections of the water-sheds.

followed, viz., that through the middle of Borneo, from the south, to Pontianak in the west.

On the 31st of October, 1847, Schwaner left Palingkau, on the river Pulu-Petak, or Batang-Murung, the right arm of the great Barito delta, in the company of the chief, Tomonggong Djaja Negara and twenty Dyaks, to commence his journey through the island.

Travelling down stream nearly to its mouth in the Java sea, he reached, by way of a Trusan, or small canal, the mighty stream, Kahajan. Schwaner followed this river for upwards of thirty-two geographical miles, as far as Tampang, 1° south latitude. Here he received the news that the mighty chief of the upper Kahajan district, through whose land he wished now to travel, Tomonggong Tundan by name, had gone to the Kapuas districts.

As Schwaner wished in any case to meet him, no other course was open than to himself find out the chief, and if possible persuade him to return home. After a three days' journey, partly on land, and partly on the rivers Koron and Sakkoi, he reached Tumbang Mohin, situated on the river Kapuas.

Here he found the chief, who immediately arranged to return home, to make preparations for receiving him with a festive welcome. He then returned by the way he had come, back to the Kahajan. He travelled up this river to Hampallas, at that time the last inhabited inland place (0° 40′ south latitude). From this it was possible, in seven days, to reach the sources of the Kahajan in the Kaminting mountains.

It was not Schwaner's intention, however, to extend his journey in a more northerly direction. To have done so, indeed, would have necessitated other means and help than he had at his disposal; above all the inhabitants of these districts who belonged to the tribes of Ot-Danom's, would have had to be won over, which would have taken up much time; and so he resolved to return. Before doing so, however, he explored the course of the important tributary, Miri, as far as Baru, but was prevented by the swollen state and strong current of the river, from going further.

Schwaner had thus travelled over thirty-seven geographical miles of the river Kahajan, and had reached a point in the interior forty miles removed from the coast. He now began the land journey in the basin of the western tributary, Katingan, at a place called Pohong Batu, on the Kahajan.

All the praus (native boats) he had taken with him from Bandjermassin were, with the greater part of the baggage, sent back to that place, and only the most necessary articles retained. The journey did not begin very smoothly, as the chief, Tomonggong Tundan, demanded from Schwaner that he should submit himself to the custom of the country, which required of all strangers who came into the land the payment of "balas," a sum of money with which to buy animals for sacrifice, in order to reconcile the evil spirits to the presence of strangers, and further to ensure the favour of the same spirits to the inhabitants in the future. At first Schwaner refused, but was compelled at last to comply with the demand, and was then permitted to continue his journey.

This difficult journey on land, during which Schwaner fell ill, and had to take a day's rest, lasted four days; he then reached the river Rungan, a tributary of the Katingan, not far from Menihang, 1° 6′ south latitude.

Schwaner's original plan, which was to continue on an overland route from here to the river Menohing, a tributary of the Rungan, could not be carried out on account of his illness; so he travelled down the river Rungan as far as its mouth, and up the river Menohing. He sent the greater part of his escort over the land route, and met with them a few days later at a place called Tampat Tomoi, on the banks of the river Menohing.

From Tumbang Tusut, which lies on the same river, he pressed forward overland into the basin of the Katingan. After only a few miles' journey, he reached the divide and soon after the river Mentohei, a tributary of the Sampa, and, following this large stream, he travelled as far as Penta Tapan, where it empties into the majestic river Kahajan. This overland journey occupied three days.

The chief of this district, Tomonggong Singa Laut, was immediately informed of Schwaner's arrival, but soon the news came that he had gone to Bandjermassin some few days back. In his stead, some of his relations volunteered to accompany Schwaner, who, after an unwilling stay of a few days on account of heavy rains and swollen rivers, resumed his journey up the river Katingan, and reached the Senamang, the second largest of its tributaries. Here his travelling companions left him, and he continued his journey alone as far as Riam Batang, 1° south latitude.

From this place, the most dangerous part of the journey, and with it the greatest hardships, began. This was the journey over the mountains which form the divide between south and west Borneo.

The chief of Riam Batang, who was well acquainted with this part of the country and its inhabitants, was induced by the offer of a reward to join the expedition, and after all preparations had been made, the land-route was chosen. At the end of the first day the last inhabited inland place was reached, namely, Indang Oreng, where a day's rest was taken. He then pushed on into the wilderness towards the springs of the river Senamang, a very hostile district, where there was imminent danger of being murdered by some of the warlike Punans who swarmed around.[1]

[1] Schwaner describes this road as follows: "A steep path brought us to the foot of the mountain Ot-Senamang, to a ravine out of which rushed the the narrow river. We entered the ravine, and climbed over numerous rocks,

The source of the Senamang is found in the cleft of a rock, which towers up wall-like for 160 feet over the springs at Ot-Senamang. The mountain ridge itself forms the divide between south and west Borneo. To the northwards, in the plain, the brook Hambrau winds its way; it belongs to the basin of the river Kapuas Bohang (West Borneo). Looking south, one sees the Senamang (South Borneo). The height of Ot-Senamang is reckoned by Schwaner at 1,020 Dutch ells; its position is 0° 43′ south latitude, 112° 21′ east longitude; and at 112° 5′ eastward he crossed the water-parting.

This difficult march lasted five days longer through these parts before the first inhabited place in West Borneo was reached, namely, Kotta Dengan Kamai, on the river Tjerundung. Having taken a well-earned rest here, a day's journey brought them to Tumbang Tjerundung on the Serawai, where this difficult overland route, which had lasted ten days, came to an end. Then, having procured boats, he resumed the journey by water. From Serawai he soon reached the river Melahui and travelling down this, arrived in seven days at Sintang, a large trading place on the river Kapuas.

Here they were in complete safety, and after five days of further marching, Schwaner reached Pontianak, the chief place in West Borneo, with all his travelling companions

---

protecting ourselves from the force of the frequent waterfalls. The whole district is a horrid wilderness. On all sides rise up steep and high ridges, clothed with stunted bushes and long gray moss. Some of the granite rocks have fallen into the valley; and long, bald, reddish streaks on the hill-sides, show the path down which they dashed. These blocks lie scattered in the damp abyss, embraced by the roots of the trees which, though dead, still cling to the cold rock from which they formerly derived their meagre nourishment. The rocks obstruct the course of the water, which is forced to seek an outlet in a thousand foaming cascades. Not a single sign betrays the presence of living creatures in this desolate district: only the rushing sound of the raging waters disturbs the stillness. Silently we climbed on, now and then exchanging significant glances when we crossed the fresh traces of the nomad and murderous tribe of the Punans."

from South Borneo alive and in good health. This was on the 2nd of February, 1848, after a journey of three months.

The results of this wonderful journey are at the present time still of great value, as up to the present day no one else has ventured so far into the interior, and under existing circumstances no one is likely to do so. And although, many years later, a few of these very distant regions were visited,[1] no one has since crossed the water-parting.

Schwaner is generally held to be the first European who travelled across Borneo from south to west, but Von Gaffron (also a German, and Schwaner's former travelling companion on the river Barito), had undertaken a similar journey before him, and had also crossed the south-west boundary mountains about fifteen geographical miles further west. Schwaner himself, in speaking in his work ("Borneo" II. p. 200) of his arrival at Sintang (West Borneo), says that Von Gaffron had already been there. The reason why this journey is so little known, lies in the fact that nothing is mentioned of it in his four large papers, published by Pynaffel, in the form of a treatise, some years after Schwaner's.

While Schwaner was making these journeys through South Borneo, there was another explorer busy with scientific investigations, namely, the above-mentioned Heinrich von Gaffron.[2] He was born in 1813 in a village called Gräbel, in the Prussian province of Silesia, and entered the military service, which he soon left, with the rank of officer. In 1838 he went to India, where he entered the military service. Scarcely eight months had elapsed from the date of his arrival in Batavia before he accompanied a scientific expedition to Celebes and the Molluccas. He had the good fortune to become acquainted with the Dutch traveller,

[1] Michielson S. 46.

[2] For Works see: S. 15, S. 27, S. 10, S. 17, W. 16, B. 15*a*. For account of life, see Tidjschrift voor Ned. Indië, 1887, January, p. 33, and in the introduction to the second part of Carl Bock's "Seis in Znid-vost Borneo (Dutch).

Forsten, who was a member of the Natural History Commission, and was preparing for a journey to Celebes, etc. Forsten begged the government to allow Von Gaffron to accompany him as draughtsman. Thus it came that Von Gaffron spent the years 1840 to 1842, travelling in the Minahassa, in Halmaheira, Gorontalo, Banda, and Ceram, and helped Forsten to map the Minahassa.

When Forsten died at Ambon, in 1843, Von Gaffron had in preparation another map of this island. This formed the basis of the map of Amboyna in the Atlas of Dutch India, by Melvill van Carnbée and Versteeg.

In 1843 Von Gaffron was appointed draughtsman to Schwaner, accompanying him the same year to Bandjermassin (South Borneo), and again on his journey to the east coast (Pulu-Laut, Pagattan, Tanah-Bumbu, Passir), and on the journey along the river Barito.[1] With Schwaner he crossed the mountains separating South Borneo and Kutei. He was also his companion on the journey along the river Kapuas to above the tributary Mawat.

Von Gaffron made an independent topographical survey of a portion of the Tanah-Laut district to the south of G. Beratus. Here he discovered, in 1844, a few localities for iron-ore, which later on were more closely examined by the engineer, Rant. Similarly, he mapped the course of the river Barito as far as its tributary Boboat; remained for a time at Bahan; mapped the tributaries Lauung, Teweh, Montallat, Pattai, and Siong; and visited the Melihat mountains on the boundary of Passir.

In 1846 Von Gaffron was placed in the service of Weddik, the well-known Governor of Borneo, who commissioned him to explore the then totally unknown western part of South Borneo, and to prospect for coal. He now mapped the coast line from Bandjermassin as far as Cape Sambar,

---

[1] Here he reached Sungei Boboat. See Von Gaffron B. 15*a*.

and prepared a map of the following river-basins:—Katingan (= Mendawei), Sampit (= Mentaja), Pembuan, Kotaringin, Djellei, and Matan. On this map he marked all the places where useful minerals had been found, and commented on the geological relations of these districts.[1] His works form a very valuable supplement to the results of Schwaner, who investigated the river districts lying to the east (Barito, Kapuas, Kahajan, and the upper course of the Katingan); and it is these two travellers we have to thank almost exclusively for our knowledge of the greater part of South Borneo.

On the 1st of December, 1846, Von Gaffron undertook his great journey across Borneo, the execution of a similar plan having been previously thwarted by the Resident. He navigated the Kotaringin, or Lamandau, as far as its source; crossed the water-parting on the 1st of January, 1847, also the south-west boundary mountains (112° 20′ east of Gr.); went along the rivers Ora, Pinoh, and Melawi; and on the 27th January, after many dangers and privations, reached Sintang, on the Kapuas, and, a few days later, Pontianak. Von Gaffron undertook this journey a year earlier than Schwaner, and was thus the first European who had succeeded in crossing Borneo.

In 1848 he retired from military service, and was appointed Administrator, and in 1849 Director, of the Coal Mines in Pengaron, the government at the same time expressing their entire satisfaction with his conduct. It was not long however before complaints were heard against him with regard to his treatment of the convicts engaged in the mines. Consequently he was removed from his post in 1852, and placed on trial, being charged with "having misused his authority, and of having ill-treated his prisoners." He was

[1] It is to be regretted that his reports (S. 27) were not published *in extenso*; for then it would have been possible to determine how far Von Gaffron penetrated into the different river-basins, which now is impossible.

sentenced to four years imprisonment. A few months later, however, he was reprieved, and placed in the service of the Resident of West Borneo.

In 1854 he accompanied the Resident to the upper Kapuas river. The highlands of Kapuas were united into one district just at this time, and he was appointed Assistant-Resident, his headquarters being at Sintang.

In the following years he undertook various journeys on the Kapuas travelling along it as far as the last-inhabited place, Lunsa (113° east longitude, and 0° 40′ north latitude). He also investigated the tributaries Ambalau, Paling, Mandei, and Mandalem, navigating the last-named stream as far as 1° 50′ north latitude.

In 1859 he took part in a military expedition, under Colonel Nauta, to the upper basin of the river Melawi, where he gained the Wilhelm order, the highest military decoration obtainable.

In the meantime he had been released from his former post as Assistant-Resident (in 1858), and charged with the secret mission of mapping the boundary between Sambas and Sarawak. In 1860 was appointed Assistant-Resident in Billiton, where he remained until 1868. He then went to Europe to spend a two years' holiday, and, on returning to India, was appointed Superintendent-General of the Customs in Batavia, which post he held until his death on the 2nd November, 1880. He had served his second fatherland (having become naturalised) for a period of forty years.

Travels in East Borneo.

During the time that Horner, Müller, Von Gaffron, and Schwaner, were undertaking scientific expeditions in South Borneo, Von Dewall, a civil service officer, was engaged similarly in East Borneo.

H. T. F. K. W. E. A. C. von Dewall,[1] a German by birth went to India, like many of his countrymen, as a soldier; in the course of time he distinguished himself, and in 1846 was appointed civil officer (with the rank of Assistant-Resident) for Kutei, by the then Governor of Borneo, Weddik. This post he filled until 1852. Animated by a strong desire to explore the almost entirely unknown provinces of the east coast, he undertook, in 1846 to 1849, several expeditions, during which he traversed the whole country from Pagattan to Tidung. With regard to discoveries made in East Borneo, he decidedly takes the first place, and although he possessed no special scientific knowledge, his communications deserve all the more praise, as they treat of a country almost entirely unknown.

In Kutei he navigated the river Mahakkam as far as Long-merah (1° 30′ north latitude) to the foot of the mountain-districts. On this journey he met with Schwaner as before mentioned, and travelled in his company to Long-merah.

During another journey in 1846, he travelled through the southern states. He had quarrels to smooth over with some of the chiefs of these provinces, and he therefore chose the nearest overland route. In the province of Passir he navigated the Kendilo up to its confluence with the tributary Komam. Then he went from Olong Sarirong overland to Olong Langun (on the Komam), and thence, travelling in a westerly direction, he crossed the divide between East and South Borneo at a

[1] The biographical data have been kindly furnished me by Prof. Veth. His works are given: E. 3, E. 6, E. 7. The travels in the Southern States (E. 3) were published by Weddik in abstract. The travels in the Northern States were published by Hageman, partly as his own work, although he made use of Von Dewall's reports (E. 7); partly under Von Dewall's name, or signed by him (E. 6). Von Dewall's maps (especially those of the basin of the R. Mahakkam) have not been published; but, together with the coast-surveys, they form the base of Versteeg's atlas, which is correct in all essential points. It is a pity that his journals were not published *in extenso*.

It is remarkable that Hooze (E. 14) always speaks of Van de Wal, although in all the old writings the name appears as Von Dewall.

point to the north of the Kramu mountains, (1° 25′ south latitude). Finally he reached the river Uye, a tributary of the Tabalong, and, travelling down this into the Negaras, reached the Barito, and so got back to Bandjermassin, the capital of South Borneo.

Like Schwaner in Central Borneo, who crossed the land dividing South from East Borneo in two different places, the untiring Von Dewall traversed it at points twenty and thirty-five miles respectively to the south. The whole journey from Kutei to Bandjermassin lasted from the 24th of July to the 2nd of September, 1846.[1] In 1847 he was commissioned by the government to investigate the coal districts near the river Mahakkam, which had been discovered a short time previously, finding coal in twelve different places.[2] In 1848 he visited the Kusan country; travelled up the river Pagattan; thence overland to the river Sela, a tributary of the Batulitjin; and returned in a more westerly direction towards the river Kusan.

In 1849 he visited those states of the east coast that lie to the north of Kutei (Tidung included) as far as the river Sibuco. From 1855–1873, until his death, Von Dewall, was well-known as an adept in the Malay languages, and busied himself with their study, but, however, without coming to any definite results. The fact is worthy of mention that he had intended to explore the central mountains of Borneo, and to settle the boundary between Brunei and Berau. This brilliant plan, however, was never carried out, as the government, who were principally interested in the political results of the journey, placed the mission in the hands of Schwaner, and after his death, into those of Dr. Croockewit; the latter, however, only penetrated as far as Kusan. The results of Von Dewall's travels, have retained their interest to the present day, as have those of Schwaner and

---

[1] Weddik, E. 3. [2] C. de Groot, S. 23, in the Jaarboek, p. 78.

Von Gaffron, in the river-basins of South Borneo; and this, in spite of the fact that forty years have passed since then, there exists no work dealing with the interior which contains such valuable geographical and geological data as Von Dewall's; indeed, with the exception of a few places near the coast, we have no other European information about the country.[1]

There are also some few civil officers besides the above-mentioned men, who were prominent in the noble rivalry displayed in the opening up of Dutch Borneo. One of the first of these is A. L. Weddik,[2] appointed Governor[3] of Borneo in 1844. In 1846 he undertook a journey on the river Barito, up which he travelled inland as far as the tributary Bahan.[4] He further travelled along the east coast, and communicated his observations, together with the results of others, especially Von Dewall's, in one work.

In West Borneo, in 1845, he travelled with Von Gaffron through the southern states, Sukadana, Matan, and Simpang; and in 1848 explored the river Kapuas as far as the river Bunut, also its tributary the Taban Kanan.[5]

Weddik is also known through having undertaken expeditions into the Batta provinces in West Sumatra.

Not less devoted to scientific exploration was Gallois,[6] Resident of South-east Borneo, who in addition to his official duties, found time to enter into scientific matters. Thus he wrote a book on the coal mine of Pengaron, and published

---

[1] Carl Bock (S. 44), who, thirty-four years later, navigated the Mahakkam on his journey from East to South Borneo, furnished scarcely any new details, and absolutely no new geographical information.

[2] For Works see E. 3 (Von Dewall) and S. 11.

[3] The post of Governor only existed for a short time; after which the two separate Residencies of South-east and West Borneo were re-established.

[4] The furthest point on the R. Barito was reached by Henrici in the beginning of the thirties: Horner reached the R. Bumban in 1836; Schwaner, the R. Lauung in 1845 (?); von Gaffron, the R. Boboat (with Schwaner ?); Weddik, the R. Bahan in 1846.

[5] S. Veth W. 14, I. p. 32.

[6] For Works see E. 9.

drawings made during a journey along the east coast of Borneo. Another account of the east coast is supplied by Capellen.[1]

TRAVELS IN WEST BORNEO.

Many investigations were made in West Borneo in the forties, although these were not carried out on so large a scale as in South-east Borneo, since the greater portion of the work was done there by members of the Natural History Commission.

Beyond the writings of Schwaner, Von Gaffron, and Weddik, who also visited West Borneo during their travels, and who have described some parts of this Residency, we meet here principally with purely topographical works.

In 1843 Kessel[2] undertook a journey with Sergeant-Major Ullman, both Germans, and mapped the district from the north of the river Kapuas as far as the boundary of Sarawak (the states Sambas, Mampava, Pontianak, Landak, Tajan, Meliau, Sanggau). Their map, which was on a scale of 1 in 250,000, was never published, but was used in the making of Versteeg's Atlas.

Kessel's description of the oro-hydrographic relations, is the best of these times; he even mentions the presence of gold and diamonds.

Five years later Van Lynden[3] travelled on the river Kapuas, inland, as far as Sungei Ambolah;[4] at the last-named place

---

[1] For Works see E. 2.

[2] For Works see E. 9.

[3] For Works see E. 11. D. W. J. C. Baron van Lynden was born in 1818, in Wageningen (Holland), and went to the East Indies in 1841. At first he lived in Batavia; between 1846 and 1848 he was Assistant-Resident for one-and-a-half years in Pontianak, and undertook some journeys in the Kapuas. From 1848 to 1852 he was Resident in Timor, and here also carried on some scientific work (in the islands near Timor, belonging to this Residency). He died at the age of thirty-three. (N. T. V. N. J. III. 1851, p. 493.)

[4] On the Kapuas river, in West Borneo, journeys were made by the following:—Tobias, 1822, as far as Sintang; Dungen Gronovius, 1822, as far

there are Dyak settlements. His geographical description is accurate; he also reported on ores and salt lakes.

In 1851, De Groll[1] undertook a journey to Blitong, to prospect for coal. The results of his journey are published, together with those of Van Lynden, in one essay.

Although much has been done by these investigations from a geographical stand-point, the geological structure of West Borneo still remains obscure, while that of South-east Borneo, has, on the whole, been correctly determined.

In the beginning of the fifties, we find but few travels or investigations; but mention must be made of those of J. H. Croockewit, Ph.D., an offspring of a very esteemed family in Amsterdam. He was born in 1823, and went to India in 1848, in order to make scientific investigations. Although not in the service of the government, he was occasionally employed by them. In 1849–50, he investigated, at the instance of the government, the tin-washings at Bangka, Malakka, and Billiton. A year later he was appointed, temporarily, to make mineral investigations in Dutch India, and was selected for travels in Borneo, in the place of the late Dr Schwaner.

H. von Dewall (see his works), had already sent in a scheme to the Indian government for exploring the central mountain-chain of Borneo. The government, however, modified his plan by putting other investigations into the foreground which were more important for their own interests. Thus Von Dewall and Croockewit[2] were first to

---

as Sintang; Hartman, 1823, as far as Djonkong; G. Müller, 1824, as far as R. Atong; Henrici, 1830, as far as Sintang; Van Lynden, 1847, as far as R. Maloh; Weddik, 1848, as far as Bunut and its tributary Taban Kanan; Everwyn, 1853, as far as R. Ambaloh, and up this as far as Olah Pau; Von Gaffron, 1857, reached Lunsa, above the mouth of the R. Madalam; G. Müller went the furthest—seven geographical miles further than Everwyn and Von Gaffron.

[1] See E. 11.

[2] According to personal communications from Prof. P. J. Veth; see S. 13, W. 24 and 26.

examine and to regulate the boundary between Pagattan and Kusan: as also they were to investigate the mineral wealth of the latter country, and further to determine in what degree the island of Laut was suitable for mining and agriculture. It was not till the conclusion of these investigations that a greater journey was to be undertaken from Bandjermassin, the object of which was to map the interior along the boundary of Passir, the basin of the river Mahakkam (= Kutei), the kingdoms Bulongan and Tidung, and the boundaries of Kutei and Berau with Brunei. According to the government rescript, "the travellers were to be guided by these investigations to the central mountains of Borneo, and to the rivers that have their sources there: and the results of this journey were to furnish the materials necessary for a general map of Dutch Borneo." Of this great scheme, only the beginning was carried out—namely, the boundaries of Pagattan and Kusan were setttled, and the mineral wealth of the latter country examined.

No further travels seem to have been made; for nothing is to be found about South-east Borneo after the year 1852, either from Croockewit or Von Dewall, and even the official annual reports contain no details of other travels. The investigations of Dr. Croockewit in South-east Borneo did not bring much to light, and were only of short duration.

In 1852 Dr. Croockewit was engaged in chemico-mineralogical investigations, in the chemical laboratory at Buitenzorg. In 1854 he went to West Borneo to make scientific investigations, visited the G. Klam with Von Gaffron, the Pening mountains, the salt wells near the river Spank, and the district of Palo. In 1855 he was definitely appointed, and received a commission to examine the coal-beds on the rivers Kapuas and Melawi, in the interests of the steam navigation of the first-named river. The results have not been published, but Everwyn mentions, that in 1856, Dr. Croockewit made a careful search for coal in the neighbourhood of

Teloh-Dah on the Kapuas (above Sintang). In 1856 he was commissioned to work out scientifically the meteorological data which had been collected in West Borneo. In 1858 he went on leave of absence to Holland, and after his return filled only administrative posts; thus, in 1867, he was appointed Resident of Bangka. He was pensioned in 1873, and died at Nymegen, in Holland, in 1880.

To be mentioned further are some few journeys undertaken in the fifties by various civil officers. H. G. Maks,[1] a civil officer of the greater and lesser Dyak provinces, undertook, in 1853, in the months of November and December, a journey along the Kahajan as far as Open Batu (= the "Pohon Batu" of Schwaner), which point (about 0° 35′ south latitude) had been reached by Schwaner some years previously. During a second journey in 1859, he travelled up the river Kapuas-Murung as far as Mahiak, which lies on the tributary Sirat. Thence he returned, travelling down the Kapuas for a short distance; he then went the same way overland, as far as the Upper Kahajan river, as had been travelled over by Schwaner a few years previously. From Kampong Mohing (Samuhing), he journeyed along the Samuhing stream, and past the Bukit Riwut as far as Kampong Lakkoi, then along the stream of the same name, until it joins the Kahajan; travelling down this, he came again to Pulu Petak. During these travels he carefully mapped-in the rivers.

Bangert,[2] the civil officer for the districts Dusson and Bekompai, undertook an exploration in Duson-ilir during the months of May and June, 1857. But at Buntok, on the river Barito, he was overtaken by illness and compelled to return. He imparts several new facts with regard to the tributaries on the left bank of the Barito, namely, the Patai, Siong Awang, Daju, Paku, and Karrau. He travelled along these rivers principally on foot, or in a litter (tandu).

---

[1] Maks S. 24, S. 29; Bangert S. 28; Kater W. 34. [2] Ibid.

While these journeys were going on, Cornelius Kater[1] was distinguishing himself as a traveller in West Borneo. This able official spent a great part of his lifetime in West Borneo, which he crossed in different directions. His researches do not, however, cover much geographical or geological ground.

Not to be forgotten here is the intrepid traveller Ida Pfeifer,[2] who, on her second journey round the world, was the first to cross Borneo from north to west, a deed, which, very justly, called forth admiration on all sides, on account of the great courage shown by this lady.

In 1852 Ida Pfeifer travelled from Sarawak (which lies in the state of Sarawak), to the river Batang-Lupar,[3] where Rajah Brooke had built a fort on the frontiers of his possessions, intending to start from this point.

On the 22nd of January, 1852, she began her journey up stream, as far as the foot of the Batang-Lupar mountains,[4] the water-parting between North and West Borneo. On the third day of the journey, the swampy lowlands had already disappeared, and gently undulating ranges of hills began to show themselves; these continued to increase in height, while a peak 3,000 feet high was disclosed in the background.

On this journey she nearly fell a victim to her boldness. Some of the inhabitants of a tribe who were on the war-path

---

[1] Maks S. 24, S. 29 ; Bangert S. 28 ; Kater W. 34.

[2] Ida Pfeifer: Meine zweite Weltreise (My second Journey round the World). She also visited Java, the Molluccas, and Sumatra ; and on the last-named island succeeded, at great risks, in penetrating to the neighbourhood of the great lake Toba (approaching from the W.), which feat has not been repeated.

[3] Ida Pfeifer speaks of the R. Skaran, which is one of the names of the Batang-Lupar (N. 40, p. 471); so-called after the Dyak tribe Sakarran. A tributary of the river also bears this name.

[4] She speaks of the mountain chain "Schämmel"; a name which does not appear elsewhere. The boundary mountains are known under the name of Batang-Lupar.

met her, and it was only the generally-respected flag of Rajah Brooke, which she hoisted on her boat, that saved her life: being a friend of the Rajah's, she was also received as a friend. At Peng-kalang Ling-Tugang, at the foot of the mountain-chain, the water journey ended, and on the seventh day, the 28th January, the commencement of the arduous overland route was made in the company of a native chief.

"The path led constantly through narrow valleys, in which the ascent was very tedious; these were occupied by an unbroken series of swamps and rivers, through which they were obliged to wade up to their knees. From time to time they had a view of a treble mountain-chain, of which the ridges rose one behind the other, and between them were to be seen valleys traversed by rivers. The height of the pass climbed was not more than 500 feet." On the third day the overland journey was at an end. On the 31st of January she descended the river Balang-Lupapa in a small boat, and reached the lake of Bunot, which is about four miles in circumference, and got thence through a connecting channel into the Taoman lake,[1] twice as large as the first.

From here they had a fine view, looking back on the picturesque dividing mountains, whose highest peak is 5,000 feet.

From the lake she travelled to Sintang on the Kapuas, whence Pontianak was reached in about three and a-half days. The whole journey lasted sixteen days, six of which had been spent on the water in the Sarawak district to the dividing mountains (22nd January to 27th January); the journey on land lasted three days (28th January to 30th January); two days to Sintang, and three and a-half to Pontianak.

Besides these travellers and explorers, however, we meet with many other names in the different periodicals of these

[1] According to Veth (W. 17) the Lake Luwar or Sumbeh.

years, the bearers of which were also endeavouring to bring, in one way or another, some small tribute to the sum-total of our knowledge.

Thus we find the names of A. G. Veltman, P. G. Maier, D. W. Rost van Tonningen, Bernelot Moens (who busied himself with chemical researches); further, G. M. Bleckman, J. C. J. Smits, J. Hageman, S. Bleekrode, and the missionary J. F. Becker.

Looking back over the whole of this splendid period, it appears to us as if they had just awakened from a long deep sleep, and were now hastening to make up for lost time.

This noble rivalry, which resembled youthful enthusiasm, lasted undiminished into the fifties, and then began slowly to relax, the first thirst of science having been quenched.

Properly speaking the travels of discovery conclude with this period, and make room for investigations of a geological character.

The First Period of Activity on the part of the Indian Mining-Engineers.

Soon after the formation of the corps of mining-engineers, at Batavia, in 1850, we find mining-engineers, in South-east as well as in West Borneo, eagerly busy with geological investigations appertaining to mining. Their main object was, no doubt, the search for useful minerals and for coal, but geological relations were also regarded, as far as they came under notice, and our knowledge with regard to them was increased by the labours of these men. By such means some parts of the island became better known.[1]

[1] It is worthy of note that the war also exercised an indirect but considerable influence on the increase of geographical information. Thus, during the insurrection in South Borneo (1859–1863), Ch. de Roy van Zuydewyn prepared a topographical map of the South-east Borneo for the campaign.

Work of the Mining-Engineers in South-east Borneo, 1852-1859.

Here we meet with two names—C. de Groot[1] and Rant.[2]

In the year 1852 the Indian mining engineer, C. de Groot, was sent to South Borneo in order to inspect the coal-mine of Pengaron, which had been working for the last four years. Before he left for Bandjermassin he endeavoured to acquaint himself with the researches already made in Tanah-Laut; but in this, however, he was disappointed, as there were only a few facts to be gleaned with regard to a coal mine ("de hoop") near the river Riam Kanan, which had been deserted in 1848, and a note on the one working in Pengaron. On setting foot in the island, he knew nothing as to the geological relations that were already known up to that time.[3]

On visiting the coal mine in Pengaron, C. de Groot recognised its unfavourable situation and great distance from Bandjermassin, the main station near the coast; in consequence of which an expensive water transit hindered a cheap production of the coal. On this account he endeavoured to find coal in Tanah-Laut, which might be more favourably situated. His fellow-worker, during the years 1852–1859, was, as already mentioned, the mining engineer, Rant.[4]

---

[1] For Works see B. 15, 17, 21, 22, 23, 26, 28; S. 23.

[2] For Works see S. 19, 20.

[3] C. de Groot S. 23, in the Jaarboek, p. 39.

This is the more remarkable as Horner and Schwaner had completed their travels as early as the year 1836; and similarly Schwaner had visited Tanah Laut, and discovered there the coal-beds. The key to this mystery is, however, the fact that the works of these men were not published till years later. Thus, the works of Henrici, Müller, and Von Gaffron were not published till 1859 and 1860, after lying unutilized for *twenty years* in the Archives. Schwaner's report, as "Die Steinkohlen im Reiche Bandjermassin," first saw the light in 1857, ten years after it was handed in.

[4] C. de Groot was himself in Borneo in the years 1852, 1853, and 1855 (S. 23, p. 1).

The coal-formation near the river Riam Kanan was known from Lok-pinong, the first mine, as far as Pengaron and Assahan. C. de Groot now endeavoured to find coal in the vicinity of Martapura, and in a more south-westerly direction towards the sea-coast.

He learned that near the Gunong Lawak pieces of coal had been found in a diamond mine. In the river Pring, in the vicinity of Martapura, he found almost unworn fragments of coal. From a bore-hole in the same neighbourhood he also obtained pieces of coal. In the brook Pinang, to the east of the Bassun hills, he met with coal and coaly sandstone, and the same in other places.

On the strength of these facts he succeeded in proving the presence of coal in three places: (1) near the Bassun hills, at a depth of four metres, a highly inclined seam of 1.25 metres thickness (the coal was laminated, and free from resin and iron pyrites); (2) near Mount Mungu-alung a coal out-crop of 0.62 metres thickness (dipping 15° east of north and west of south), with good coal; (3) near the brook Danau-Krassik, an immense seam, with good coal, 0.90 metres thick, containing some resin and pyrites (strike, south-east and north-west; dip, 10° to south-west).

By the discovery of these localities, the coal formation of Pengaron became known to within a distance of 21 kilometres from the sea coast; while Rant proved the unbroken continuation of coal-seams from Pengaron to Gunong Djabok.

From the varying strike and dip it appeared, however, that between Pengaron and Banju-irang there must be some considerable disturbance of the strata. At the same time De Groot did not think it necessary to lay too great a stress on this, as the stratigraphical relations were only known at a few points.

Search was also made for coal at other places in Tanah-Laut. Thus, in 1853, Rant found earthy brown coal of little value near Tandjong-batu; he also prospected for coal in the

the same year, near the river Assem-assem, where its occurrence was already known by official report. In a hilly district, three hours' distance from the coast, twelve seams of brown coal make their appearance (strike, east and west; dip, 45° to south).[1]

On the east coast search was also made for coal. Thus, in 1852, C. de Groot investigated, at the instance of government, the occurrence of coal on the Island of Laut, where it had already been discovered two years previously by Ihle, at Cape Pamantjingan. In several places it crops out in disturbed stratigraphical relations, dipping towards the sea. Although of good quality, he held it to be not worth working on account of its disturbed bedding.

He also submitted the coal out-crops on the river Mahakkam, in Kutei, to a more careful examination, they had been temporarily investigated by Von Dewall.[2] He established the good quality of this coal, and at the same time the equivalence of its age to that of the coal of Pengaron. As a result of these investigations a coal-mine was opened in 1861 in the range of hills called Pelarang.

But the geological relations in Tanah-Laut, in Pulu-Laut, and in Kutei, were also thoroughly investigated by him, and he prepared a geological map, showing his travels.[3] In this work he was assisted by Rant, the latter mapping the rivers Riam Kiwa and Riam Kanan from Pengaron or Karangintan to Martapura, and further, the river Martapura to Bandjermassin, where it runs into the river Barito (near Schanz-van-Tuyl).[4]

The specimens of rock collected on these journeys were turned to account by De Groot in his geological reports.

Further, Rant investigated in 1854 more fully the localities for iron-ore discovered by Von Gaffron[5] in 1844, during his

---

1 Rant S. 19. 2 See p. 27. 3 J. v/h. M. 1874, II.

4 His map was published by P. van Dijk in J. v/h. M. 1883, I.

5 V. Gaffron, S. 15.

topographical surveys in Tanah-Laut, in the range of hills called Pamattang-damar, and in other places where he (Rant) had been sent in order to fetch 15,000 kilos of ore for samples.[1]

Of the coal found in Tanah-Laut that from Gunong Djabok and Djalamadi proved to be the most valuable; and this place, being situated on the Riam Kanan, was nearly half as far from Bandjermassin as Pengaron. It seemed possible, therefore, to furnish cheaper coal here than that produced at Pengaron, and engineer Rant was commissioned to establish its value by boring operations.

The work was nearly at an end, when the insurrection of 1859 broke out, in which the whole boring party, with the exception of Rant, who happened just at this time to be absent, were murdered, and the works completely devastated.

Work of the Mining-Engineers in West Borneo, 1853–57.

Soon after the formation of the corps of mining-engineers, a mining engineer was sent to the western and southern Residency of Borneo, to prospect for useful minerals.

The geology of West Borneo was, up to the beginning of the fifties, almost entirely unknown.[2] The task of making scientific reports on this part of the island fell to the mining engineer Everwyn.[3] The various journeys which were undertaken between the years 1853 and 1857 were associated with many hardships. The political condition was at this time very unfavourable. An insurrection existed in the Chinese

---

1 Rant S. 20.

2 The journeys which up to this time had been made, had chiefly produced topographical results. Everwyn, therefore, had in West Borneo a much more unbroken field for investigations than had, for instance, De Groot in the southern part of the island.

3 For Works see W. 25, 28, 35, 37, 39, 53.

districts[1] during the first years of the investigation, and in the rest of the inland states the influence of the Indian government was so little felt that Everwyn was not only unsupported in his endeavours, but met with opposition nearly everywhere on the part of the people and their rulers, no one being willing to show him any localities for useful minerals.

In addition to this, travelling by water was then less easy, and more wearisome than some years later, when the means of conveyance had been bettered; further, Everwyn had not the necessary European help, and much time was lost in correspondence with Batavia, so that altogether only twenty-one months were spent in the investigations proper. They consist entirely of geological travels, made within an area of 2,150 square miles, in which only the results of personal observation were noted and marked on the map.

The states Sukadana, Simpang, Matan, Kandawangan, and the Karimata Islands lying to the south, were visited by Everwyn during the years 1854–1855, his visits occupying several months. His main object was to search in these districts for tin-ore, which G. Müller and Gaffron had already shown to exist here, many samples of supposed tin-sand having been sent to Batavia for examination. All the samples, however, turned out to be iron-sand, and only one small sample from Abut (R. Pesaguan), collected by an European official in Sukadana, contained a small amount of tin. Nevertheless, all investigation led to a negative result, and even near Abut no tin-sand was found. The earlier reports of Müller and Gaffron were probably based entirely on the statements of natives. Nor was anything found

---

1 By the "Chinese Districts," a name often used in this work, is meant the auriferious districts north of Pontianak, which are peopled by numerous Chinese. They embrace the following administrative divisions :—Mampawa, Landak, Montrado, Sambas, *i.e.* the N.W. part of West Borneo.

on the Karimata Islands, which lie to the west of Sukadana, whence a supposed sample of tin-ore had been sent.

During the years 1853, 1856, and 1857, traverses were made along the river Kapuas, in search of coal. Near Sintang, near Salimbau, in basin of the tributaries of the Buuot, and in other places, coal out-crops were found, and it was proved that these strata constitute the Eocene coal-basin of the Kapuas, which spreads out in a westerly direction, as far as the Spauk.

Nothing was decided with regard to the working qualities of the coal, as on account of the small inclination of the strata, this could only be proved by boring. From the Spauk down to the river Tajan, Everwyn proved the presence of unimportant beds of brown coal.

These journeys furnished fossil evidence of the existence of an Eocene formation, similar to that present near Pengaron, in South Borneo; also of the existence of late Tertiary strata of a different petrographical habit, of which the age could not be accurately determined. Further, the distribution of alluvial gold and diamonds in the plains of the Kapuas valley was ascertained.

In 1854 and 1857, journeys were made in the Chinese districts, in order to prospect there for copper-ores. These ores were found to be widely distributed in the neighbourhood of Mandor, where it was present mainly in alluvial form, but was also found in the rock, in disseminated grains, in patches, nests, and small veins. These deposits showed themselves to be of no value for working purposes.

Everwyn also gives valuable information concerning alluvial gold in Sambas and Landak.

During fully twenty years, namely, from 1860 to 1880, no official investigations were undertaken by the mining world. In West Borneo the unfavourable reports of Everwyn appear to have discouraged further search. In South Borneo the insurrection had put an end to all research work.

During these twenty years no Indian mining-engineer set foot in West Borneo,[1] and in South Borneo only one, who was entrusted with the management of the coal mine at Pengaron. Verbeek,[2] in his spare time, and at his own cost, had studied the geological relations of the neighbourhood of Pengaron, in the years 1869 and 1870, during which period the management of the mine was entrusted to him; and had published a work entitled *A Geological Description of the Districts Riam Kanan and Kiwa, in South Borneo.*" This is the first work on Borneo in which the geological relations of a district were accurately and exactly described; and, similarly, the geological map, published by him, is the first of its kind. What had previously been only known in general was now worked out in great detail and in a smaller area.

Second Period of Activity of the Indian Mining-Engineers, 1880–1888.

South-east Borneo.—The idea of C. de Groot, in the beginning of the fifties, to find a more favourable place for a new coal mine, the carrying out of which, however, had been frustrated by the war which broke out in 1859, was, after a period of twenty years, again taken up in 1880; for the mine in Pengaron, being unable to produce coal at a cheap rate, had been obliged to stop working. The boring investigations, begun by Rant in 1859 near the Gunong Djalamadi, were resumed; but it was soon seen that the coal-beds were too disturbed to allow of regular working.

Under the management of the able mining engineer Hooze,[3] the search for more favourable situated coal-seams was begun on the east coast of Borneo. The coal-seams on

---

[1] During this period there appeared only two papers relating to West Borneo: Peeters W. 32; Schultz W. 38.

[2] For Works see S. 40, 41; B. 38, W. 60.

[3] For Works see Hooze E. 13.

the north-west coast of Pulu-Laut, where C. de Groot had already prospected, were subjected to a second investigation, but with the same results as before, it being again shown that the coal was of a medium quality, and not worth working, owing to its not being present in sufficient quantity.

After this, the states Sambiliung and Gunong-Tabor were prospected for coal (1882 to April, 1883). Near Gunong-Tabor coal had been known siuce 1848, the Sultan of the land having supplied this fuel from Sambiliung to passing ships. The coal occurring in the Sawar-hill range was also examined for a distance of from ten to fifteen kilometres up the river Berau. It was also sought for on the river Mahakkam in Kutei, as well as in the Pamukan and Klumpang Bays. The geology of these places was closely studied. Besides prospecting for coal on the east coast, Hooze had a second commission to fulfil, namely, to make a geological map of Tanah-Laut, with special reference to the gold and diamond fields.

This work served to complete that of the districts Riam Kanan and Kiwa by Verbeek, whereby the whole of the south-east part of Borneo now became accurately known. Hooze's investigations are still going on, and the results will not be published for some years.

West Borneo.—After an interval of twenty years, the mining engineer, van Schelle, was commissioned in 1880,[1] to map the geological and mining relations of the Chinese districts, and especially to study the gold fields, as well as to search for gold-bearing veins; these were the same districts in which Everwyn had already prosecuted geological researches in 1857, and which he reported as being worthy of detailed investigation.[2] The boundaries of this special survey were

---

[1] Reports: W. 42, 43, 44; 46–52; 54–58; 62–64; 66–70.
[2] Everwyn: J. v/h. M. 1879 I. 115.

fixed as follows:—on the west by the Chinese Sea; on the north by the river Sambas; on the east by the river Landak; and on the south by the road leading from Mampawa to Mandor and Landak. Van Schelle described, in many small treatises, his prospecting work for antimony ore, quicksilver, and gold veins. Also in the above districts, he prospected for ores near the rivers Katungan and Labojan on the borders of Sarawak, also for coal near Napan, on the river Bojan, in the district of Bunot. He did not visit the southern states.

Beyond the papers of the mining engineers, published in the last few years, there is very little other literature. Thus Martin[1] examined the rocks which had been collected by Horner in Central Borneo, but had been left packed up and unused till then. Posewitz[2] also published some notes on Central Borneo.

Still more surprising is the absence of journeys on a larger scale, like those in the fifties, which would have furthered our geographical and geological knowledge of more distant states. Few names[3] can be mentioned in this connection; those of the Dane, Carl Bock,[4] and of W. J. M. Michielson,[5] being the most prominent. Carl Bock undertook a journey in 1880. He travelled in the company of the Sultan of Kutei, from the east coast of Kutei up to the river Mahakkam as far as Muhara Pahit,[6] and then followed the same road over the dividing mountains that Schwaner had travelled over forty years previously. Crossing the boundary he reached the basin of the river Teweh, and travelled down this tributary

---

1 Martin 39, B. 39.

2 Posewitz S. 49, 50, 51, 53.

3 J. W. C. Gerlack's journey in West Borneo (W. 45) was only an annual journey of inspection to an out-lying fort.

4 Bock S. 44*a*.

5 Michielsen S. 46.

6 Bock's statement, that the district above Muhara Pahit was unknown before his journey, is incorrect. Schwaner and Von Dewall's travels in that district appear to have been unknown to him.

of the Barito into the main stream, proceeding thence to Bandjermassin. Although this enterprise should not be passed over without mention, still it did not enlarge our geographical or geological knowledge, as Bock was chiefly of ethnographical bent. In Kutei Bock followed the course of the rivers Telen and Klintjan, tributaries of the Mahakkam, up to above Long Wai, in the hill country. Geology and geography profited very little by this journey.[1]

In the beginning of the eighties Michielson, civil officer (Controller) in Sampit, journeyed to the most remote provinces of his department in the upper districts of Sampit and Katingan. From his residence in Sampit[2] he proceeded up the river bearing the same name, and then down its tributary, Kalong. Thence he continued his journey on foot to the near-lying Katingan, and navigated this upwards as far as Telok-Tampang, on the river Senamang. He began his return journey on the river Katingan, which he followed as far as the mouth of the small tributary Kalanaman lying on the right bank, up which he went in order to return to the Sampit river-basin. He travelled on foot over the territory which parts the waters of the river Kalanaman (Katingan), from those of Tambaga (Sampit), and after a four months' absence reached Sampit in safety. We have him to thank for many geographical and geological notes.

The travels of the missionary Hendrich,[3] on the river Katingan, are also worthy of note. On official business he travelled by sea (in 1885) from Kwala Kapuas to the mouth of the river Katingan, and up this as far as Tumbang Sampa, which lies at the mouth of the tributary Sampa (1° 30′ south latitude). The river is navigable for steamers as far as that

---

[1] Neither did Bock make any new ethnographical observations of importance.

[2] The districts traversed by Michielsen had been visited forty years before by Schwaner and von Gaffron.

[3] S. 50.

place, and thence to its mouth it measures fifty-seven geographical miles. A little distance further up stream, the first cataracts make their appearance.

Hendrich also travelled up a small portion of the tributary Sampa, returning by the same route. His journey lasted from the 2nd of June to the 9th of July, that is forty-two days. It offers nothing new from a geographical standpoint, but is remarkable for having been undertaken, in the middle and lower parts of a river, in an altogether uncivilised district, and the courage of the traveller is shown by the fact that he carried it out without any escort whatever.

Fr. Grabowsky, a German naturalist, now an official of the German New Guinea Company, also travelled during the eighties on the river Kapuas, and in the districts bordering on the mountains of Pengaron to Amunthai, and further into the districts of Dusson Timor. Unfortunately, not much has been published respecting these travels up to the present time.

The civil officer Arnout also made great journeys in his district (Upper Dusson).

North Borneo.—The travels and investigations appertaining to the northern parts of the island were made independently of the geographical and geological discoveries made in Dutch Borneo, as another colonial power had taken root here. From political relations alone, it is possible to draw *a priori* conclusions, with regard to investigations made at different times in the various districts.

As in Dutch Borneo, we can distinguish between an older and a newer period of investigations; and the mining engineers show considerable activity, although not in the same proportion as in the case of the well-organised corps of mining engineers in Batavia.

During the earlier period, the explorations which began about the forties, and lasted into the sixties, varied considerably, according to the different districts traversed.

The state of Sarawak, being the first to come under European rule, namely, in 1841, offered the greatest facilities to those who wished to travel without danger; whilst in the remaining parts of North Borneo (Brunei and Sabah), only very few journeys were ventured upon.

Exclusive of Alexander Dalrymple,[1] to whom our thanks are due for the earliest reports of any value on North Borneo, (since the year 1769) the first scientific traveller was R. Burns.[2] In 1848 this explorer made a journey along the rivers Tatau, Bilian, and Bintulu. He followed the eastern branch of the last-named river to its source; thence he went overland to the river Pelaga, a tributary of the Redjang, and travelled down this to its mouth; he then made his way up a second tributary, Pelawi, to the river Tatau, and returned to the coast by an overland route.[3] Later on he travelled on the river Barram,[4] as far as the settlements of the Kajans, and furnished us with the first information regarding these states He died in the Bay of Marudu in 1851.

Hugh Low,[5] Colonial Secretary in Labuan, who navigated the river Sarawak and its tributary, paid especial attention to the occurrence of minerals.

We have to thank Spenser St. John,[6] Consul-General in Borneo, for the best and most detailed reports on Sarawak and Brunei, and for the only knowledge we possess of Sabah. His travels play the same part in North Borneo, as do Schwaner's in the south, and Dewall's in the east of the island.

In the state of Sarawak, he travelled over the basin of the river Sakarang, followed the Batang-Lupar river down to below

---

[1] Crocker N. 34, p. 206.

[2] Burns N. 3.

[3] See Veth W. 17 I. p. lxxxviii.

[4] This river was also navigated in the forties by the English steamer "Pluto"; see N. 6.

[5] H. Low N. 1.

[6] Spencer, St. John, N. 9, N. 10, N. 13.

Marup, and visited its tributaries, Sakarang and Lingga, being the first European on the last-named river. On the river Sarawak he reached its source. Further, he travelled up the river Kanowit, a tributary on the left bank of the Redjang, to where it empties into this river, and then down the last-named powerful stream (on the Egan branch) to its mouth in the Chinese Sea.

In the State of Brunei he travelled on the river Barram (as Burns had done before him), and was the first European to follow the course of the river Limbang, and its tributary, the river Mahidi, deep into the interior of the island—namely, as far as the border mountains of Brunei.

In the country known as Sabah, he travelled along the coasts from the river Kimanis beyond the mouth of the river Sibucco; described the surroundings accurately, and furnished a topographical map of North Borneo. Accompanied by Low in 1858, who, however, was soon left behind on account of an injured foot, he also climbed the mighty Kina-balu, taking the road along the river Tampassuk, and furnished an accurate description of this high mountain.[1]

The work of Spenser St. John will always retain its value, and his name will ever fill an honourable place in the history of discovery in North Borneo.

To be mentioned here, too, is the daring German traveller, Ida Pfeifer,[2] who was the first European to cross (in 1852) the border land between Sarawak and West Borneo, and to traverse Borneo from north to west.

Scientific and geological investigations were also made by a private mining engineer named J. Motley,[3] who described the coal seams on the island of Labuan.

---

[1] He left a note in a bottle on the top stating that he had ascended Kina-balu with Low. Thirty-eight years later this was found by R. M. Little, when he ascended the mountain in 1886. (*Br. N. B. Herald*, 1886, July.)

[2] See p. 31. [3] J. Motley N. 7.

During the second period of discoveries we meet with the name of the Italian traveller, O. Beccari,[1] who sojourned in these states during the years 1865 to 1868.

After making a few excursions on the river Sarawak, ascending a few mountains, and exploring some caves, he followed the river Batang-Lupar down to the place called Marup, and made the ascent of Mount Tian-Ladju, which is about 3,000 feet high.

Thence he made a journey (in 1866) across the borders of Sarawak, to the lake district of the river Kapuas in West Borneo, where he took the same route which the daring Ida Pfeifer had taken fourteen years previously (in 1852). After this he travelled along the coast of Sarawak to Cape Datu, and visited the river Lundu.

On another journey he came to Labuan and Brunei, and navigated the river Bintulu, with the intention of reaching, on its upper course, the basin of the river Barram. As he could not carry out this intention, he travelled along the Tuban, the left tributary of the river Bintulu, for four days, reached the river Bellaga, a tributary on the right bank of the river Redjang, and travelled down this as far as the mouth of the Egan.

He undertook another journey on the river Redjang as far as the tributary Kanowit, on its right bank. Proceeding up the latter, and crossing the water-parting, he reached the rivers Sakaran and Batang-Lupar. The latter he navigated as far as the mouth of the river Lingga, travelled up this for a considerable distance, crossed the divide, reached the river Simunjan, and thence the river Sadong. He travelled among the ramifications of the mouths of this river as far as the Sarawak. The results of this journey show that Beccari is undoubtedly to be classed with the first travellers of Sarawak. He crossed this state through its

---

[1] O. Beccari N. 12.

whole length, traversing the basins of the rivers Bintulu, Redjang, Batang-Lupar, Sadong, and Sarawak.

It is to be regretted that Beccari was only a botanist, and that, consequently, his journeys do not furnish much new matter of geographical and geological interest. The most important part of his work is the communication of native reports on the central mountains of Borneo.

J. Xanthus should also be mentioned. He stayed for some time in Sarawak, in the year 1870, to make scientific and ethnographic collections. Xanthus navigated the river Simunjan to the lake of the same name, from which the river Simunjan receives its waters. He[1] also visited some smaller streams which empty into the lake.

The travels of C. de Crespigny[2] in the beginning of the seventies on the rivers Mukah and Oya, furnish next to nothing new of geological or geographical interest.

The newest literature on Sarawak is to be found in the writings of W. M. Crocker,[3] who was Resident in Sarawak for sixteen years. He travelled over the river-basin of the Sarawak, visited the delta of the river Redjang, and navigagated on a small steamer the rivers lying to the east as far as the boundary of Brunei. He travelled through the border lands between Sarawak and West Borneo, as Ida Pfeifer and Beccari had already done before him.

From the fort Labok Antu, on the river Batang-Lupar, he went to the Dutch fort Nanga-Badau, reached the river Pes-aya in about three hours' journey, and after travelling for four hours more, arrived at its mouth, which opens into Lake Seriang. His works, together with the accompanying map, are of great value. With regard to Sarawak we have, in the second period, only the geological reports of F. Gröder[4] (mining-engineer of the Borneo Company), and of the

---

[1] Xanthus N. 30*a*.

[2] C. de Crespigny N. 14.

[3] W. M. Crocker N. 34.

[4] F. Gröder N. 21.

very energetic A. H. Everett.[1] While the former only describes the occurrence of antimony and quicksilver in Sarawak, we have to thank the latter almost exclusively for our geological knowledge of the state of Sarawak. This untiring investigator and concise observer, describes in detail the useful minerals of Sarawak. He also explored caves, in the hope of finding remains of diluvial animals, similar to those found in the caves of Europe, and among them, perhaps, the forefathers of the anthropoid apes now living in Borneo. By this means he expected to obtain either positive or negative evidence with regard to the descent of man.

We see from Everett's geological sketch of Sarawak, in which he makes no difference between the old limestone formation and the late-Tertiary coral reefs, that the geological structure of this country is identical with that of the "Chinese districts" of West Borneo. The presence of late-Tertiary eruptive rocks is also indicated.

In Brunei there are only two recent travellers—namely, C. de Crespigny[2] and Leys.[3] The former navigated the rivers Padas and Lawas in the beginning of the seventies, and furnished some important geological and geographical facts with regard to them. (His journeys in Sarawak have already been referred to above.)

Leys travelled in the beginning of the eighties along the rivers Padas, Lawas, and Limbang. The first-mentioned river has been visited within the last thirty or forty years by four or five Europeans; the river Lawas by two or three; and the river Limbang, only once, namely, by St. John in 1858.

Our geographical and geological knowledge of Sabah has received a considerable addition during recent times. As

[1] A. H. Everett N. 22, 23, 24, 28, 29.
[2] C. de Crespigny N. 15.
[3] Leys N. 46.

already mentioned, there is in the fifties but one work (that of Spenser St. John), dealing with these districts, which to the beginning of the eighties were the most unknown of the whole of Borneo.

In the seventies the island Borneo was visited by foreign warships on their way to the far east, thereby contributing to our knowledge of these inhospitable and unexplored districts. During a journey to Japan in 1873, Giordano[1] and Bove[2] visited the northern parts of Borneo in the Italian warship, "Governolo." Coming from Singapore they touched at Sarawak, Labuan, Brunei, steered along the coast in the Bay of Marudu, and thence into the Bay of Sandakan. There the proposed journey on the river Kinabatangan had, for want of time, to be abandoned.

The new facts furnished by this journey are a geological and geographical description of Banquey Island, lying near the north-east point, and of the ascent of Mount Kinabalu (the second by Europeans).[3] The route up this mountain differed from that of Spenser St. John made seventeen years previously.

From the river Tawaran, the Italian travellers went to the river Tampasuk, which St. John had first navigated, and thence to above Kiang, they followed the same route. The journey was commenced from a place called Gantisang, lying at the north-east end of the Bay of Gaya, which is environed by low hills. Having reached the river Menkabong, they travelled up it to above the lakes, and then began the journey on foot.

Near Tamparuli they entered the plain of the river Tawaran, and, travelling along this, reached Bawang (place and mountain), where the first climbing began. The first

---

[1] F. Giordano N. 19.

[2] G. Bove N. 20.

[3] This journey had already been made by Lobb, Low, and St. John in the fifties.

mountain village, Sinilan, was reached at an altitude of 410 metres, while the place called Kalawat, lying on a plateau of the mountain of the same name, was reached at a height of 1,000 metres. The last place in the basin of the river Tawaran was Bungol; for Kuong, the next place reached, lies in the basin of the river Tampassuck. From this point the real ascent of the Kina-balu began. After the first day's march, 1,800 metres had been ascended.[1] Here on account of bad weather they were obliged to turn back, and reached the coast by the same way as they had come.

The geological and geographical notes contained in the reports of these travellers, are for the greater part mentioned by Spenser St. John.

Two years later, 1875, the Austrian corvette, "Friedrich,"[2] visited the shores of Borneo.

From Singapore, passing Batavia and Surabaya, they steered for the Island of Borneo, sailed round Pulu-Laut, along the east coast to the north-east point, and then along the north coast to Cape Datu, the most north-westerly point. Here their journey ceased, and they returned to Singapore. The journey had lasted fifty days, the ships travelling over 1,400 sea miles. Land was touched in the provinces of Passir, Baien, Sibuco, Sandakan, Marudu, and on the island of Labuan.

The scientific results of this journey, which was quite incorrectly designated a "Voyage round Borneo,"[3] are a topographical survey of a part of the coast on the north end of the Bay of Sibuco, and some extremely interesting studies on the formation of land in the Sunda district.[4]

---

1 2,700 metres, according to Giordano. N. 19, p. 195.

2 Job. Fr. von Österreicher B. 31.

3 Professor Veth first pointed out the inaccuracy of this statement in the preface to von Rosenberg's "Der Malayische Archipel." Leipzig, 1879; and an article in the *Ausland*, 1879, N. 25, p. 34, entitled "Die Erforschung Borneos," treats the same subject, supporting Professor Veth.

4 J. v. Lehnert B. 42.

With the exception of the journeys of the two warships above mentioned, the scientific results of which only refer to the coasts (for the ascent of the Kina-balu, by Giordano and Bove furnished nothing new), our knowledge of the north-east point of the island was in no way extended before the end of the seventies.

The interior of these districts remained as inhospitable and unknown as before, as is very plainly shown on the topographical map.

But in 1881, when the British North Borneo Company acquired the territory of Sabah, and began to colonize it, our geographical and geological knowledge increased with every year. A large number of courageous pioneers appeared on the scene, who were not afraid to traverse these unknown regions in any direction. They defied the dangers which met them at every step; and consequently, we already possess, after the lapse of a few years, a large amount of information respecting the most unknown districts of Borneo. And should our information continue to increase in like proportion, those parts which up to the beginning of the eighties were least known, will, in a comparatively short time, become best known to us.

Honour to the memory of the men who sacrificed themselves for science, and to the nation which could produce such great results in so short a time!

The later travels of discovery, or more properly speaking, the beginning of the discoveries in Sabah, commenced about the end of the seventies. The first traveller was Mr. T. T. Dobrée,[1] an owner of plantations in Ceylon, who examined the adaptability of the newly-acquired territory of Sabah, for the cultivation of coffee in 1878. He visited on the west coast the rivers Pappar, Galamuti, Leemai, and the country lying between them; further the neighbourhood

---

[1] J. Hatton N. 35, p. 86–93.

between the rivers Tampassuk and Pandassan, and the Valley of Ginambar. On the east coast he visited the Bay of Sandakan and environs, as well as the rivers Kinabatangan and Sagaliud (by him termed "Se-Gally-Hood"). The scientific results of these travels are very scanty.

In 1879, J. Peltzer[1] was commissioned by the "British North Borneo Company" to undertake explorations into the interior of Sabah, for the same purpose as Dobrée. These journeys were also of great use in increasing our geographical knowledge. During his sojourn of three years in this part of Borneo, Peltzer undertook a journey (on the 5th of February, 1879), with the purpose of discovering the sources of the rivers Kimanis[2] and Pappar. On the 15th January in the same year, he travelled up the river Tampassuk, to investigate its source, and to scale the mountain declivities of Kina-balu.

During this journey he reached the places called Kiang or Kian (already visited by Spenser St. John and Bove some years previously), traversed the Penekok valley, and climbed the Marei-Parei Peak of the Kina-balu *massif.* Returning to Kian, he passed through the districts to the south-east of Kina-balu, and after scaling several mountain ridges, reached the great valley plain of Suau.

In 1880, W. F. Witti began his important explorations in Sabah. Witti[3] was a retired Austrian naval officer, who went on his own account to North Borneo, and entered the service of the English Trading Company. His first journey

---

[1] J. Peltzer N. 33. Other routes are given on the map than are described in the text.

[2] On the "Croquis du Borneo Septentrional," which accompanies the text (N. 33), Peltzer's route is given as following the river Kimanis as far as the plain of Nabai, and thence returning to the coast down Padas. From his description, however, one would not conclude that he went down the Padas. On p. 385, "Le retour à Kimanis (von Nabai) s'effectua sans incident remarquable," which indicates that he returned the same way as he went; otherwise he would certainly have described the new route.

[3] Witti N. 41, 42.

was a visit to the oil springs on the river Sequati, and overland from the Bay of Marudu to the river Pappar. On the 4th of November, 1880, he left the river Agai and landed at Agar-point, whence he proceeded to the neighbouring mouth of the Sequati river, to investigate the occurrence of petroleum.

From Layer-Layer, on the north-west coast, he followed the course of the river to Moroli, and then traversed various places, going round Kina-balu to the east. At a place called Tambunan, Witti reached the river Padas, which he followed up for some distance, in order to cross over the divide into the basin of the river Pappar. He navigated the latter down to the coast. After an absence of thirty-two days he again reached his residence in Tampassuk. One of the most interesting geographical results of this journey was the proof that no lake existed to the east of the Kina-balu, as had previously been supposed.

His second great journey was commenced on the 13th of May, 1881. He travelled overland from the Bay of Marudu to the Bay of Sandakan. From Bongon (Bay of Marudu), he traversed the country to the north-east of Kina-balu, and reached the river Linogu (= Labuk), near a place called Tamalan. Down this he travelled as far as Punguh, resumed his overland journey as far as the Lukan, a tributary of the river Kinabatangan, navigated this towards the sea to Sebangang, and thence travelled to Sandakan.[1]

His third journey was undertaken on the 9th of March, 1882, when he travelled up the river Kimanis on the west coast (Pagalan province). The journey by water was to the mouth of the river Sawatan, a tributary of the Kimanis; then began the march overland to the Nabai plateau, 900 metres high (which J. Peltzer had also visited by the same route), along the course of the river Pampang. From

[1] J. Hatton N. 35.

Limbawan, the capital of the Nabai State, he could clearly see the central chain of the Kina-balu Mountains stretching towards the east. From this point, he followed the upper course of the river Pangalan, and among other things proved that this river is not to be regarded as the upper course of the Padas.[1]

His fourth great journey was with the object of investigating the unknown district between the river Kimanis in the west, and the river Sibuco in the east (Dent Province, and southern part of the East Coast Province). Although advised not to journey through these dangerous districts, he did not allow himself to be prevented from carrying out his plan. It cost him his life, however. He was murdered by the natives in 1882.[2]

L. S. von Donop,[3] Agricultural Commissioner to the "North British Trading Company," undertook a journey in 1882, round the Kina-balu Mountains. Travelling up the river Sampas on the north-west coast, he took the route followed by Low and St. John, several years previously, as far as Kiang. He then travelled southward round the Kina-balu *massif*, reached in the east the former route of Witti, and went thence in a northerly direction to the Bay of Marudu. He undertook a second journey with the geologist, F. Hatton, to investigate the west side of the Kina-balu *massif*. From Kinarum (lying near the Bay of Marudu), they travelled in a south-westerly direction to Kiang Gendokud, and came as far as the river Tampassuk. In this way they succeeded in completing the circle round the Kina-balu *massif*. Von Donop further visited the Tambuyukon Mountains, and traversed in October, 1882, the land extending from the Bay of Marudu to the upper course of the river Sugut, which he reached at a place called Sinagas, already visited by Witti before him. He returned to the Bay of Marudu by another route.

---

1 Witti's Journal N. 41. 2 F. Hatton N. 48. 3 Diary of von Donop N. 43.

W. B. Pryer,[1] an official of the "North Borneo Trading Company," also undertook several journeys in Sabah on a small steamer. He proceeded up the mighty river Kinabatangan in 1881 towards the interior of the country, until, after five days, further progress was hindered by the extensive sandbanks in the bed of the river. Pryer then followed its course in a native boat up to a place called Imbok, above the mouth of the river Quamota, over 300 miles inland. Altogether, it was navigated for a distance of 150 English miles further than it had been by any European up to that time.[2] He followed, in the same way, another large river named the Alfred, which empties into the extensive lagoons of the river Kinabatangan, not far from the sea.

The French traveller, Dr. Montano,[3] must also be mentioned. On his journeys to the far east, he visited North Borneo, where he followed the lower course of the river Sagalind, which empties into the Bay of Sandakan. His work was mainly anthropological; he furnished nothing new of geographical import.

In 1881, a great addition was made to the geological knowledge of Sabah, by the explorations of F. Hatton,[4] who was as fearless as he was able. He entered the service of the "English North Borneo Company," as a "mineral explorer," and was the only one among travellers in this part of Borneo who had received a scientific education. He travelled on the rivers Sequati and Kurina; followed, during another journey, the river Labuk towards its source, and thence proceeded overland to Kudat to the Bay of Marudu. On a third journey, he travelled up the Kinabatangan river to the Pinungah, and then, following the latter, reached Tungara, thus going much further than anyone had gone

[1] Pryer N. 39.
[2] Overbeck navigated the river for 230 English miles. N. 26, p. 122.
[3] Montano N. 31. [4] F. Hatton N. 48.

before him. During a fourth journey he visited the river Sagamah, but unhappily did not come back alive: his gun going off accidentally, he was fatally wounded, and died soon after, in his twenty-third year, in 1883. His death was a heavy loss to the Company which he served, and to the science for which he lost his life.

Among the travellers of modern times who visited Sabah, D. D. Daly,[1] also deserves mention. He undertook, during the years 1883 to 1887, a journey in Kinabatangan, and a journey along the river Padas, reaching districts which had never been visited by Europeans before him. In the year 1884 he travelled from Sandakan to the mouth of the river Kinabatangan, and journeyed several miles up this river to Pinungah, the same place which F. Hatton had also reached. Here the river divides into two branches, the Melian, or Kinabatangan proper, and the Mungcapo. For three days Daly travelled up the tributary Melicop, in order to reach the Obang-Obang[2] caves situated in a range of limestone hills. Before him nobody had been on this tributary. He was unfortunately prevented from undertaking another journey up the river Pinungah (already navigated as far as Sungara by F. Hatton) to the Senobang Caves, and, therefore, returned to Sandakan after an absence of sixty-four days. During a second journey he navigated the river Padas, the chief river of the Dent Province on the west coast. As far as the beginning of the mountain-chains he travelled in a canoe, then crossing the mountain-chain on foot, he reached the tributary Pagalan, which comes from the N.E., while the Padas itself flows to the S.E. The return journey was made by the same route. We have him to thank for several new facts in geography; he also furnished some important geological data.

---

[1] D. D. Daly N. 51.

[2] This should surely be Lobang-lobang.—Author's note.

(4) CRITICAL SUMMARY OF THE RESULTS OF THE EXPLORATIONS.

Of the travellers mentioned above, we shall only take into consideration those who have done service to geology during their explorations. The first to be mentioned are Horner and Schwaner, members of the "Natural History Commission," and their companion, von Gaffron; then the mining engineers, C. de Groot, Verbeek, and Hooze, in S. Borneo, and Everwyn and van Schelle, in W. Borneo.

In N. Borneo there have been no geologists except Gröder and F. Hatton.

Work of the "Natural History Commission," and of von Gaffron.

In respect to Horner and Schwaner, we must treat their work in Tanah-Laut separately from that in other districts. Their work, as also that of von Gaffron, is still, after a lapse of forty years, of actual value, as, with few exceptions, no one else has supplied us with information on these districts. It is different with the work in Tanah-Laut. At the present day it is only of historical interest, as the mining engineers have been busy here in more recent times, and, having more time and better means at their disposal, have more fully investigated the geological relations of the district.

The investigations of Horner and Schwaner[1] in Tanah-Laut serve as a test for the accuracy of their general views and opinions in other districts, for, as already mentioned, this district has been repeatedly and thoroughly re-examined.

[1] They are treated somewhat fully, in order to emphasize the important part played by these men in the geological investigation of the island, and to preserve their services from oblivion, as their writings were published in old periodicals and in the Dutch language. Martin was the first to bring them into recent notice (Martin B. 39).

The results of Horner's travels[1] can be briefly summarized as follows:—The "mountain axis," consists of old eruptive rocks, with which mica-schist is associated in places: it is traversed by auriferous quartz-reefs. It is surrounded by a belt of sandstones with interbedded coal-seams, marls, and limestones, succeeded by a younger pebbly formation.

Central Borneo (District of the river Barito).

Conclusions as to the nature of the "mountain axis" can be drawn from the pebbles found in the rivers, where rock-crystal and quartz, impregnated with iron-pyrites, indicate plutonic rocks. This "mountain axis" is surrounded by a belt of secondary rocks, consisting of sandstones, with interbedded coal-seams, marls, and limestones, and penetrated by eruptive rocks. The sandstones and limestones of Sungei Bumban, for instance, are traversed by dykes of a greenish augite-porphyry, and a grey trachyte, with small glassy crystals of felspar; trachyte-conglomerate and slaggy lavas being also found.

The stratigraphical relations are much disturbed. The strike is in general north and south, with deviations towards the east and west. Along the Murung (Barito) the strike and dip change as often as twenty times.

The Secondary rocks are also developed on the river Teweh, where they consist of sandstones and coral limestones, white and blue cavernous rocks, with scattered shells and corals (*astraea mœandrina*). Here the strike is also north and south, with deviations towards the east and west; the dip is 12–40°. This formation is succeeded by Tertiary beds. Travelling up the Barito, they are first found at Gunong Rantau, the first elevation on the Barito, and, a little further towards the north, at Bahai Hill. Horizontally stratified

[1] The writings of Horner are: "Verslag van een geologisch onderzoek van het zuidoostelyk gedeelte van Borneo" (S. 2). Mention is also made of them by S. Müller in his "Reisen in den indischen Archipel." (S. 22).

quartz-conglomerates, knit together by a ferruginous cement, are found here. The proportion of iron is often so great, that nodules of brown iron-stone have been found. Beds of brown coal, with woody structure, alternating with clay slates, are also found here; these rest on clayey marl. Horner regards these beds as a littoral formation.

Tanah-Laut.—The Ratus mountains, and the other parallel chains, are composed of gabbro, serpentine, diorite, granite, and syenite, with numerous metalliferous veins. The quartz veins are auriferous, and gold was also found in the diorite and syenite. These rocks, especially the diorite, contain a considerable amount of magnetic iron-ore, which has often separated out in large quantities. They are associated in places, for instance, in the neighbourhood of Riam Arinawe, with dark green mica-schists, which are traversed in all directions by quartz-veins. Above them follow sandstones and limestones (coral-limestones of Martaraman) which belong to the Jurassic. These beds are occasionally broken through by dioritic and porphyritic rocks, in consequence of which a "friction-conglomerate" has been produced. The latter also occurs on some of the eastern mountain ridges.

According to Horner there are two coal formations, neither of which, however, is older than the Tertiary. In the younger formation, the brown coal still shows woody structure; and layers of clay, interspersed with nodules of iron-stone, occur in alternating layers. The greatest part of the Tanah-Laut district consists of a horizontally stratified conglomerate formation—quartzose conglomerate and brown iron-stone, or layers of red earth and conglomerate—containing gold and diamonds. This is mostly underlaid by serpentine, with an undulating surface. The clay is derived from the decomposition of older rocks, the quartz from the metalliferous veins; and a similar origin must be ascribed to the noble metal. This formation is a littoral one; the quartz fragments are found only in one bed, because the clay being removed by wave action, the heavier quartz sinks. The view that the formation is littoral and of no great antiquity, is favoured by the fact that near Gunong Lawak marl and limestone pebbles occur which contain species of shells still living. Further, in the overlying beds, at a depth of from two to three metres, an iron anchor and the remains of houses were found.

The original source of the gold is, according to Horner, in the quartz veins. The matrix of the diamonds he considers to be the Batu-timahan (corundum accompanying the diamonds), which, according to him, is also a veinstone. The formation of the "Danans,"—the dried "Antassans,"—is also mentioned by Horner. The formations in the Tanah-Laut and Barito districts are also compared with one another, and especially the sandstone beds on the Sungei Karangintan (Tanah-Laut) with those on the Barito.

Horner's sketch of the geological structure of Borneo is, on the whole, correct; but the ages of the respective beds are in part incorrectly named. Thus, for instance, he and Müller describe the Tertiary sandstones and limestones as "Secondary formations," chiefly grounding the assumption of their greater age on numerous stratigraphical disturbances; although, on the other hand, he noticed the great resemblance between the corals of the limestones of Liang Naga and those of the present time. He also compared the fucoids of the sandstones of Lontimtur with a species belonging to the chalk. In the Tanah-Laut district he describes them as Jurassic. In this, however, he is only following Leonhard's precept, who described similar rocks in Timor as Jurassic. The pebbly formation is compared by Horner with the younger Tertiary; although in other places he mentions that, in consequence of the human implements found therein, they must be of younger age. These contradictions are in great part explained by the fact that Horner did not himself edit and publish his notes.[1]

---

[1] Martin B. 39, p. 292-294.

Schwaner's Work.

Let us now turn to Schwaner's investigations.

The results of his travels in the south-east of Borneo, in the Tanah-Laut district, are at the present day only of historical interest, since this district has been examined in more recent years by the mining engineers De Groot, Rant, Verbeek, and Hooze, who have made us better acquainted with its geological relations.

Schwaner's extensive travels in the basins of the rivers Barito, Kapuas, Kahajan, Katingan, and Melahui, however, have, even at the present time, a real value. Since the forties, when Schwaner, undertook his famous travels, no one else has penetrated so far into the interior: no one else has dared the dangers of the boundary mountains. Isolated journeys have been made in later years by civil officers on the rivers Kapuas and Kahajan; but they have contributed little that is new to geographical or to geological science. We have to thank Schwaner almost entirely for our knowledge of these districts; and as matters now stand, a long time will elapse before the researches of this renowned investigator are supplemented. To him also we owe most of our knowledge of the basin of the river Barito. In this basin no important travels have been undertaken in later years, excepting that of Karl Bock, which, however, affords no new geological matter. Similarly we have nothing with regard to Tanah-Bumbu later than Schwaner's communication. But the value of his work is increased by the fact that he, like Horner, correctly sketched the larger features of the geological structure of South Borneo, and that the formations which he described, especially with regard to their age, still possess their full value. He describes the simple but characteristic structure of Borneo, by representing the mountains as islands occurring in a hill-land, and, among other things, mentions the occurrence of marshes in the diluvium of the hill-land, and even of the mountain-land.

According to him the mountain-land is made up of granitic, dioritic, and old schistose rocks; with which trachytes and porphyries are associated. It is in dealing with these rocks that Schwaner made his one mistake, viz., in making no distinction in age between the plutonic and the volcanic rocks. He says, for instance, "the hill-formation has been elevated by plutonic rocks, and abundantly disturbed by the intrusion of dioritic rocks," among which syenite is mentioned.

He regards the hill-land as consisting of sedimentary beds, and as of Tertiary age.[1] It consists of sandstone beds alternating with shales, and containing seams of brown coal. All the coal seams are described as brown coal, and a different geological age is assigned to them; but he admits of nothing older than the Tertiary, as is still acknowledged at present. The limestone formation, consisting of corals, which surrounds the hill-land, is described as coast formation.[2] In this limestone (on the river Riam Kiwa) fossils are often so abundantly present that they make up the greater portion of the rock, the calcareous matter only being found cementing the material between them. The fossils show that the limestone belongs to the Tertiary period. For the most part the numerous remains of nummulina give us a sure indication of its age.[3] The beds of sand and clay overlying the hill-land, in the first of which gold, platinum, and diamonds occur, are quite correctly regarded as belonging to the Diluvial period. The Alluvium is also separated from the Diluvium, and the former is described with the pen of a master.[4]

Further, it is possible to draw fairly accurate geological

---

[1] Schwaner S. 16 I, p. 23. 24, 54, 59.

[2] Ibidem I, p. 25 and 27.

[3] Martin (B. 39, p. 292) mentions that Schwaner appears to have been doubtful that the limestone-beds were of Tertiary age.

[4] Ibidem S. 16 I, p. 61.

lines from Schwaner's work in South Borneo; this is especially true of his work in the western districts, which is published in the form of a journal. He also describes the navigability of the rivers travelled over by him, and he gives several sections which give some insight into the geological structure.[1]

Unfortunately, owing to his early death, his researches could not be published under his personal supervision. His chief work:—"Borneo: Beschryving van het stroomgebied van den Barito en reizen langs eenige voornome rivieren van het zuidoostelyk gedeelte van het eiland," was published in two volumes by the "Koninklyke Instituut voor taal- land- en volkenkunde von Nederlandsch-Indie," under the supervision of Dr. J. Pynappel, in 1853. In the first volume the basins of the rivers Barito and Kapuas are treated; in the second, the basins of the rivers Kahajan, Katingan, and Melahui. The record of the latter journeys are in the form of the original journal. This is of considerable advantage to geologists as the geological boundaries can be marked in accurately on the map. This is not the case with the Barito, of which the basin is only treated generally; although, doubtless, it also originally appeared in journal form. This is the more to be regretted, as here the interesting land between the Upper Barito and the district of Kutei was traversed twice by Schwaner, so that many more details of geological interest might have been obtained from the daily entries and drawings. Pynappel, the editor, complains with justice that Schwaner has marked in accurately on his map all the villages on the rivers — places which are only too often abandoned for others—while the names of the rivers and mountains are often not given; further, that the names in many cases are incorrectly spelt. Again, no degrees of latitude and longitude are given.

---

[1] Schwaner, S. 9.

Other publications, made from the writings left by Dr. Schwaner, are: "Reis in de vorstenlanden, 1844," published in the "Tydschrift voor Nederlandsch-Indie, 1857," 2 vols. "De Steenkolen in het ryk van Bandjermassin," p. 21. No geological relations in Tanah-Laut, with especial regard to the coal, are treated in detail in this work. As will be shown in the sequel, it contains many inaccuracies, which are often contradicted in others of Schwaner's works.

Further, there was published by Croockewit, "Reis naar en aonteekeningen betreffende de steenkolen van Batoe-Belian (Z. O. kust van Borneo)," in the "Tydschrift voor Ned.-Indie, 1852." Schwaner found here, in 1846, in the chain of hills (Gunong) Garum six seams of coal, the occurrence of which resembled that on the river Riam Kiwa, and which lay nearer to Bandjermassin than the other.

Of importance is, further, a work which appeared in the "Tydschrift voor taal- land- en volkenkunde, 1853," under the title "Historicke, geographicke, en statisticke aanteekeningen betreffende Tanah-Boemboe." Schwaner found here the same formations developed as in South Borneo: a younger formation and an older series overlying the foot of the Meratus Mountains, with coral limestones stretching along by the mountains. Younger sandstones with plant-bearing coals also occur. Gold and diamonds occur abundantly in the rivers and in the diluvium.

Von Gaffron's Work.

Von Gaffron's writings on the gold fields and iron ore localities in Tanah-Laut are, I repeat, now only of historical interest; but his reports on the western part of South Borneo are still of great value, as these districts have not been re-examined, and we are, consequently, dependent on the information supplied by him. His views on the geological structure of Borneo agree with those of Horner and Schwaner, thus settling their age. Thus, he often speaks of "*Muschel* *kalk*," by which it is certain he means the Tertiary coral reefs. He was the first, however, to distinguish between the black coal of older age and the brown coal of recent age, as was done later by the Indian Mining Engineers. Von Gaffron also gives a clear insight into the orographical relations of Borneo, by pointing out that the mountain chains, in this as in other parts of Borneo, do not form connected masses, but occur only as mountain islands in the hill-land, having a general strike in a N.E. and S.W. direction. One of the chief services rendered by von Gaffron is the preparation of the first geological map of South Borneo, and of a part of the west coast as far as Pontianak. This map was published thirty-five years later, having lain during the intervening period among the state archives.[1] This geological map, which is said to have been made by him and Schwaner together, is really a record of the results of the explorations of the Natural History Commission,—viz., Schwaner, Horner (Müller), and von Gaffron. Martin has given detailed proof of the relatively great value of this map; and up to that date (forty years ago) there existed none better. He tested its actual value by comparing the part representing the south-eastern point of the island with the later results of the Indian Mining Engineers on the same ground, and came to the conclusion that the map, on the whole, supplied correct information, and was only erroneous in minor details. The conclusions as to the age of the formations are Horner's, and not Schwaner's. Much of this difficulty can be obviated by making the following alterations: for "primary and plutonic," read "old massive rocks and schists;" for "Secondary" read "Tertiary;" for "Tertiary" read "Diluvium;" for "Basalt" read "recent eruptive rocks." It is a pity that scarcely any account of von Gaffron's travels in West Borneo, which were very

[1] Martin (B. 39, p. 283) also remarks, in speaking of Horner's Reports, "The sketch-map betrays the hand of a master."

extensive, has been published. What a number of interesting facts are perhaps still hidden there!

With regard to the work of the Natural History Commission, Verbeek, the well-known Indian geologist, expresses himself rather unfavourably. He says ("Geolog. Beschryving der distrikten Riam Kiwa," etc., p. 21):—"It is true that their researches have brought to light some knowledge of the habits and customs of the Dyaks, and also of the geography and topography of some parts of Borneo, but very little of the geological structure of the island has been made known by their travels." That this criticism is unjust can be seen by glancing at their work.

Later on Verbeek turned his attention more especially to Schwaner, and demonstrates a series of inaccuracies in his work,—"De steenkolen in het ryk van Bandjermassin,"—in order to arrive at the conclusion that the geological sketch given in that work has not the smallest scientific value. (l. c., p. 24). From this statement the conclusion follows that the views of Schwaner,[1] who was the author, but not the publisher of the above work, on this district, are not of the slightest value. That Schwaner's views with regard to this district were, however, correct, is shown by a comparison of a few passages in his work on Borneo and the work cited above. Thus Verbeek[2] (p. 22) gives the following passage as incorrect:—"That it is mentioned in several places that the Gunong Bobaris runs from W. to S., while its true direction is about N.E. by E.—S.W. by W."; but in "Borneo," vol. I., p. 5, it is stated the Gunong Bobaris runs in a W.S.W. direction, that is, exactly as stated by Verbeek. On pages 23 and 24, Verbeek says: "It is clear that Schwaner did not recognize the fact that the hilly table-land in Tanah-Laut was chiefly of sedimentary origin, but believed that the land was for the most part composed of hard tuffaceous

[1] Verbeek draws the same conclusion. [2] J. v/h. Mynwezen, 1875, I.

conglomerates;" and Schwaner quotes thus:—"Wherever I crossed these hill-masses, I always found them to consist of the same material—a fragmentary rock . . ." and further:—"Only at a few places on the left bank of the river Batu Api-Riam Kiwa do we find remains of former beds of limestone and sandstone."

In "Borneo," vol. I., p. 53, it is stated:—"The kingdom of Bandjermassin, to which the Riam Kiwa belongs, can be regarded as belonging, in great part, to the hill-formation;" and on p. 54 the "hill-formation has been described by me as consisting of sedimentary beds of Tertiary age." Thus, Schwaner knew well enough that the Tertiary hill-land was chiefly of sedimentary origin. His statement that he found friction-conglomerates (=tuffs) everywhere, and fragments of limestone and sandstone beds only in a few places, shows his correctness of observation; for in this district the conditions are in general such as he described, as can be seen on Verbeek's map. On the other hand, Verbeek's remark on p. 23, that Schwaner did not separate the eruptive rocks in point of age is correct. This can be seen in several places in his work on Borneo, although he distinguishes between plutonic and volcanic rocks: this, however, is his only error.

From the above it will be seen that there is a curious contradiction in the writings of one and the same author; but that the views expressed in the work on Borneo are correct, will be seen by a study of von Gaffron's geological map, which agrees exactly with the above-mentioned views.

There are also inaccuracies in Horner and von Gaffron's work, but they all have their source in the fact that neither Schwaner, Horner, or von Gaffron, published their own works. In part they were only reports to the Indian government; in part discarded manuscripts which, originally written in the German language, remained for years unused among the state archives, until an editor was found to fuse the scattered writings into one whole. In the case of Schwaner's "Borneo," and von Gaffron's works, this was Pynaffel. But the editor of the work on the coal beds of Bandjermassin appears to have been some one whose acquaintance with geology was limited. This explains the presence of mistakes which certainly would have been avoided had the authors themselves been able to superintend the publication of their writings. The reason why Verbeek so launches out against Horner and Schwaner is mainly because he compares his work on a small district with theirs, and then, of course, finds errors in the details. But in order to do justice to the work of the "Natural History Commission," and of von Gaffron, one should consider the date at which it was done, and the extent of the ground covered. It will then be seen that their work could only be "geological reconnoitreing" carried out in unknown regions, and often in great personal danger. Taking this into consideration it must be conceded that their work was of great importance. They are undeniably the pioneers in the geography and geology of Borneo. Their general views on the geological structure of the island are still tenable, and whosoever wishes to study the geology of Borneo, must be indebted to Schwaner, Horner, and von Gaffron.

In the following table the views of the different explorers in Tanah-Laut are placed side by side:—

Comparative Table of Views on the Geology of Tanah-Laut (S. Borneo).

Description.	Horner, 1836.	Schwaner, 1844.	C. de Groot, 1852.	Verbeek, 1870.	Hooze, 1886. (Not yet published.)
MOUNTAIN LAND, "GRUNDGEBIRGE" OF HORNER,	Consists of gabbro, serpentine, diorite, granite, and mica-schist: traversed by gold-bearing quartz veins. Gold is also impregnated like magnetite, especially in diorite.	Idem. Consists of diorite, serpentine, gabbro, mica-schist, etc. —B. i., 26.	Not specially mentioned. Serpentine-formation is wide-spread.	Consists of mica-quartzite-hornbleude-schists, of gabbro, serpentine, quartz-diorite, syenite, granite.	
HILL LAND, SEDIMENTARY FORMATION,	The "Grundgebirge" is succeeded by sandstones and limestones belonging to the "secondary formation," and of Jurassic age. Von Gaffron calls the limestone "Muschelkalk."	The Meratus Mountains are surrounded by a hill-formation, composed of Tertiary sedimentary beds. The Tertiary hill-country is surrounded by a limestone or coast formation: the abundance of nummulites proves the Tertiary age of this (on the river Riam-Kiwa, near Loktjantong).	Idem. The limestone belongs to nummulite-formation. The coal-formation is older than the limestone, since it underlies it.	Is Eocene. Consists of stages: α, β, γ, Verbeek figures the nummulites. Proves the age by other fossils. Mentions also a recent Tertiary formation, probably Miocene.	
YOUNGER ERUPTIVE ROCKS, ANDESITES, AND TUFFS,	Penetrated by dioritic and porphyritic rocks, in consequence of which a friction-conglomerate (= tuff) has been formed. Makes no distinction between younger and older eruptive rocks.	Sandstones and shales are disturbed by the eruption of dioritic rocks, which resulted in the formation of friction-conglomerates. Idem.	Dioritic-porphyry, dolerite. Diabase have pierced the coal-formation. The hard, clayey sandstone and conglomerates are connected with these eruptive rocks. (In Pulu-Laut mentions Basaltvacke.)	Describes the younger eruptive rocks as andosites, and describes as such their tuffs; makes a distinction between the younger and older eruptive rocks.	
COAL,	Two coal formations, neither older than Tertiary.	The brown coal is of different ages, but not older than Tertiary: the older has no woody structure. Diluvial coal and coal of the present time.	"Black coal" (Pengaron), and brown coal (Tandjong-Batu, S. Assem-Assem).	Eocene coal (Pengaron), and younger diluvial, perhaps also younger Tertiary coal.	
DILUVIUM,	Pebbly formation, coast formation, younger Tertiary.	Pebbly formation. Diluvium.	Diluvium. Idem.	Idem.	
ALLUVIUM,	Present formation.	Idem.	Idem.	Idem.	

The Work of the Indian Mining Engineers in S. E. Borneo.

The Work of C. de Groot.[1]

C. de Groot describes the geology of this district and of the neighbourhood of Banju-irang (a former coal-mining concession), and further that of the island Datu and of the hill Tima in the district of Tanah-Laut, on the basis of a topographical survey of the rivers Riam Kiwa and Martapura,[2] which extended to the point where the latter enters the river Barito, and was made by the mining engineer Rant. The rock-specimens collected along these streams were also utilised, and the facts supplemented by personal observation.

The last-named district consists of serpentine, with veins containing copper and magnetic pyrites, and of a coarse-grained, sometimes schistose, gabbro (p. 57). The serpentine formation is of considerable extent in the Tanah-Laut district.

The coal-formation of Pengaron is exposed up stream near Lokbesar, and down stream to above Bumirata. It is older than the nummulitic limestone, as it underlies the latter, and runs from Pengaron to Banju-irang.

The limestone formation which accompanies the coal formation, consists of a compact greyish, yellowish, crystalline limestone and marlstone, containing numerous nummulites, echinoderms and corals. (Kg Balee,[3] between S. Amoniapon-besar and Maleewang), and extends to Mataraman. Between Bumirata and the latter place the limestone contains siliceous concretions (flint nodules of white,

---

1 S. 23, B. 15, 17, 21, 22, 23, 26, 28.

2 On the scale of 1 : 50,000.

3 It should be noted that several names of places, which De Groot gives on his map, do not appear on Verbeek's map H. v/h M. 1875, I. These places must have been abandoned during the war of 1859–1864.

yellow, grey, and black colours, with a hard nucleus, and containing the same fossils as the limestone, p. 45). It is the well-known nummulite formation. In the Tanah-Laut it is not found *in situ*. In Nangka, however, flint nodules were found with the same fossils as on the river Riam Kiwa.

The eruptive rocks, greenstones, that break through the coral formation are:—diorite-porphyry,[1] with scattered crystals of albite and hornblende (above Kg Balee[2] and below Kg Buntut riam); schalstein,[3] fine-grained, greyish-green, with many small scales of calcite; calcareous, diabase yellow to greenish with included grains of calcite (below S. Amonia-pon-besar);[4] and dolerite. The two last-mentioned rocks have burned the shales through which they pass, and have impregnated them with carbonic acid. In Tanah-Laut, diorite is exposed on mountain Pamalutan, close to the coal formation; and aphanite and aphanite-porphyry on the hill Pantej.

The andesite-tuff and tuff-conglomerates were not recognised by De Groot as such, although he suspected their true nature. He designated them as "greenish, hard, argillaceous sandstones passing over into argillaceous conglomerates."[5] Between Pengaron and Assahan, for instance, burned shales are exposed between the schalstein and the diabase. The influence of the greenstones has caused them to become impregnated with calcite. His words are:—"I am not clear as to whether there is any connection between the conglomerates and the shales, and whether it has anything to do with the eruptions of the greenstones." The

---

[1] Verbeek's Hornblende-andesite.

[2] On Verbeek's map, Kg riam balee.

[3] Verbeek's Augite-andesite. See S, 41, p. 81—Nos. 7, 8, 9, correspond as to description and locality.

[4] Marked on Verbeek's map as Andesite-tuff (At), between Assahan and Pengaron.

[5] Schwaner and Horner called this a "Reibungsconglomerat" (friction-conglomerate).

diluvium begins below Martaraman, the alluvium below Martapura.

On examining the coal-seams along the north-western border of the island of Laut (Pulu Laut), De Groot found that the coal dipped towards the sea, and that it was chiefly developed in the north of the island; but the beds have been much disturbed by eruptive rocks belonging to the basalt family, viz., dolerite, anamesite, amygdaloidal basalt-wacke, and basalt-wacke. It would not pay working. The search for coal in Kutei led to a nearer examination of the coal beds above Samarinda, on the river Mahakkan in the Pelarang range of hills.[1] Here De Groot found that they agreed geologically with those of Pengaron. On his geological map he has coloured as coal-bearing the river strip from Riam to Bandjermassin, several places in the Tanah-Laut, and the river Mahakkam up to above Pelarang. He distinguished between:—

Crystalline schists (Pamatang damar).
Coal formation.
Brown coal formation: S. assem-assem; B. Ulin.
Marl and siliceous limestone with nummulites—Eocene.
Bituminous and plastic clay, iron conglomerate—Diluvium.
Alluvium.

And the eruptive rocks:—

Diorite, Diabase, Aphanite, Serpentine, Basalt-wacke, Anamesite, Basalt-wacke, and Amygdaloid.

Further he mentions the localities for useful minerals.

With regard to De Groot's works, Verbeek says:—"They contain an enumeration of the rocks which are to be found on the banks of the S. Riam Kiwa. There is also a little map in which these rocks are marked with colours, from Riam to Barito. It is remarkable that tuffs and tuff-

---

[1] S. 23.

conglomerates are neither mentioned nor marked on the map." It has already been shown that De Groot's work gives a fairly accurate idea of the geology, consequently it is more than a mere enumeration of the rocks, for on p. 47 De Groot[1] says that the coal formation is older than the nummulitic limestone, lying above it. On the other hand it is correct that De Groot did not recognise the andesite-tuffs as such. He supposed them to be altered (burned) shales, produced by the influence of the greenstones, and regarded their age as similar to that of the Pengaron coal, but possibly older. De Groot again, makes no difference in the age of the eruptive rocks, but on p. 62, he says, "That probably the serpentine (in Pulu Laut) has disturbed the sedimentary beds (Tertiary)."

Verbeek's Works.[2]

Verbeek's chief work is a "Geological Description of the Districts Riam Kiwa and Riam Kanan in S. Borneo." In this detailed work we have for the first time an exact geological description of a part (about fifteen square miles) of Borneo, accompanied by a beautiful geological map. After a geographical and topographical sketch, the literature is given, and in part critically examined.[3] Existing maps are also mentioned. The geological relations are then dealt with in detail as follows:—The crystalline schists, the older eruptive rocks of G. Bobaris and Tamban (with microscopical and chemical analyses); further, the Eocene, or old Tertiary, formation; the andesites and their tuffs (microscopical and chemical); the later Tertiary formation, Diluvium and Alluvium. It has already been mentioned that the Alluvium and Diluvium[4] were correctly diagnosed before Verbeek;

---

[1] As already mentioned, De Groot did not know Horner and Schwaner's works.

[2] S. 41, p. 1-131; further, S. 40 and B. 38.

[3] S. Horner and Schwaner p. 52; De Groot p. 59.

[4] By Schwaner and C. de Groot.

Schwaner, De Groot, and P. van Dyk[1] had stated that the limestones belong to the nummulitic formation, and De Groot and van Dyk had determined the age of the coal. Verbeek's services consist in first having divided the eruptive rocks[2] into an older and a younger series; in having determined the younger Eruptive rocks to be andesites, and in describing their tuffs, which probably represent the close of the Eocene formation; in having confirmed the age of the Eocene by the discovery of fresh fossils; in having first figured the nummulites in the limestones; further, in dividing the Eocene formation more precisely into three stages than had been done before; and finally, in treating later Tertiary formation (probably miocene), a course, however, which, had been already suggested by Schwaner, De Groot, and von Gaffron.

Hooze's Work.

His chief service is an attempt to subdivide the Tertiary formation in Borneo; thus besides the Eocene beds, he gives Oligocene and Miocene. With regard to the east coast of Borneo he gives some valuable geological facts, and in Tanah-Laut he proves the existence of an old sedimentary formation (Devonian).

In West Borneo.

Everwyn's Work.[3]

While in South Borneo, even before the advent of the mining engineers, the Natural History Commission had deciphered its geological structure, a great part of West Borneo still remained unknown. It is true we had obtained from Schwaner and von Gaffron some geological informa-

---

[1] P. van Dyk B. 13.

[2] The basalts are separated from the older eruptive rocks on von Gaffron's map.

[3] W. 25, 28, 36, 37, 39, 53. All former works are collected in W. 39.

tion of the basin of the river Melawi and Sukadana, but it was small in comparison with the work done in the south.[1] It remained for Everwyn to unravel the geological structure of the west part of the island. Through him we learnt of the great Tertiary basin of the river Kapuas, and it was he who proved the identity in age of the coal-seams found there with the coal beds of Pengaron in South Borneo. In his opinion it is probable that the younger Tertiary strata form the western part of the basin of the Kapuas. He mentions further the similarity in geological structure between Sukadana and the Chinese districts, and describes the matrix of gold. In his writings he gives a sketch of the mining operations completed up to that time in West Borneo, which is of great value. The routes followed in his travels are coloured on his map. Finally, he describes the distribution of alluvial gold and diamonds, as also the occurrence of copper ore.

Van Schelle's work.

The results of these investigations can be summarized as follows:—Proof of the occurrence of the chalk formation on the river Seberuang; discovery of fossils in the old schist formation, by which its age was determined as probably Devonian; the discovery of a small volcano (Melabu); the proof that the auriferous and other veins will not pay working.

---

[1] In general, Sukadan is correctly coloured geologically, as is shown by comparison with Everwyn's later work (see Martin B. 39, p. 342).

II.—GEOLOGICAL.

PRELIMINARY DESCRIPTION.

Borneo, one of the Sunda Islands, has an area of 750,000 square kilometres. From north to south it measures 1,250 kilometres; from east to west 1,250 kilometres. It is traversed near the middle by the equator. Its boundaries are: on the south, the Java Sea; on the west, the Borneo Sea; on the north, the Chinese Sea; and on the east, the Celebes Sea, and the Macassar Straits.

Starting from a central mountainous region, the lines of water-parting branch radially, dividing the island into a southern, a northern, and an eastern portion. The divides do not, however, form connected mountain chains, but consist rather of short isolated ranges or ridges, which, running generally in a similar direction, together constitute a mountain chain. The isolated mountain islands thus produced are surrounded by a low, undulating country, which, when the mountain islands are strongly developed, becomes insignificant (as in Tanah-Laut), but when the mountains are sporadic, constitutes almost entirely the whole of the watershed (as in the district between Kutei and South Borneo). This peculiar character of the mountain land is developed everywhere in Borneo, even in the highest mountain of the island—namely, Kina-balu (13,698 feet) in the north-east. The subsidiary chains, and the numerous spurs sent off from the main chains, show the same character. They are developed abundantly at the end of the south-western central chain, where they constitute (in South-west Borneo) an extended mountain country. They also form isolated mountain masses in the middle of the hill-land. An outlier of this description is, for instance, Gunong Parrarawen, a mountain extending far towards the south.

The mountain-land is surrounded by hill-land, tongues of which project between the individual islands. Towards the low-lying plains the hill-land gradually flattens, but in the direction of the mountain chains it assumes higher forms. "These hills do not form ranges enclosing plains and valleys, nor are they very defined, as regards height and form. They may be described as an aggregate of rounded or extended masses, with often very steep sides. Their usual height seldom exceeds 200 to 300 feet: only in the neighbourhood of the divide do they become higher, and give the country a more mountainous character."[1] Like the mountain-land, the hill-land sends out spurs into the low-lying plains, appearing then as outliers, which indicate to the traveller, even from a distance, the neighbourhood of the hill-land. The hill-land, in its turn, is bordered by low-lying plains, which are of great extent, especially in South Borneo. On the borders of the plains is a dry flat land, which, however, gradually passes into the marshy plains of the swamp-land. Here, again, we find outliers of the dry flat swamp-land. "Instead of valleys and plains at the foot of the hills, we often find swamps and marshes" [Schwaner]; they are even present in the mountain-land, according to accounts given in published travels. On the other hand, the outliers of the dry flat land stretch far into the swampy low lands, and isolated high-lying districts are then formed in the middle of marshy, low-lying plains. This is the remarkable tectonic structure which characterises Borneo. The island consists of mountain-land, hill-land, dry flat-land, and wet swamp-land, each of which borders the

---

[1] Schwaner, S. 16 I, p. 3.

other, and appears as outliers which extend far beyond its natural limits.

The geological formations of Borneo, comprise old crystalline schists and eruptive rocks of the nature of granite and diorite; and Devonian, Carboniferous, Cretaceous, older and younger Tertiaries (Eocene, Oligocene, Miocene), Diluvium, and Alluvium.

The presence of Carboniferous and Cretaceous rocks among the older sedimentary formations has only been determined in the last few years. The probable age of the Devonian formation, also known as "the old slate formation," has only been lately proved.

The crystalline schists cannot in many cases be separated from the Devonian and the Carboniferous. Since the latter only occur, as far as we know at present, in the northern part of Borneo, there only remain the crystalline schists and Devonian rocks, which must of necessity be treated together, as they always unite to form the mountain-land. I shall introduce them under the name of the "mountain formation," along with the igneous rocks associated with them. They comprise:—mica- hornblende-quartzite-, and felsite- schists; also clay-phyllite, and subordinate sandstones.

The igneous rocks are granites and diorites, the former appearing at a lower horizon than the latter. Belonging to a later period are gabbros and serpentines. That they are of Pre-Tertiary age is probable, but not yet proved.

The Tertiary beds are treated in the sequel under the name of hill-land, this being their tectonic character. Up to recent years they were separated into Eocene[1] and Miocene; to these in later years the Oligocene has been added. All four stages of the Eocene are developed in Borneo. The first or "Breccia-stage," consisting of conglomerates and

[1] Verbeek's classification.

sandstones, is, up to the present, only known in West Borneo. The second, or "sandstone-stage," is of great thickness and wide development: it yields the Indian coal, and consists of quartz, sandstone, shales, and coal seams. The third or marl stage consists of marls and shales, with isolated nummulites, many orbitoids, lammelibranchs, and crustaceans. The fourth or "limestone-stage," which forms coral reefs, contains numerous fossils, among which are nummulites and many orbitoids. These strata are broken through and disturbed by basalts, augite- and hornblende-andesites, which are associated with breccias, conglomerates, and tuffs of eruptive origin. The age of these rocks is probably Miocene, for the limestone stage is also pierced by them. As to the composition of the younger Tertiary formations, little is known, or published. They appear, however, to consist also of sandstone, marl, and limestone beds; and the limestones are said to occur as coral reefs.

The hill-land is flanked by the flat-land (Diluvium), which forms a belt round it and penetrates it, lying at the foot and on the slopes of the mountains. It constitutes a flat and but slightly undulating plain, consisting of clayey, sandy, and pebbly beds, and passes over gradually into the Alluvium. Of great practical importance is the fact that platinum, diamonds, and gold, occur abundantly in this formation. The Alluvium forming the marshy low-lands is of great lateral extent. It is surrounded on all sides by a belt of dry land (Diluvium). In South Borneo the alluvial lowlands are of widespread occurrence; in the west a part of the Kapuas plain, and in the east, the plain of the river Mahakkam consists of marsh-land. On the other hand, the alluvial formations in North Borneo are of small extent.

(1) PHYSICAL GEOGRAPHY.

With regard to the mountain systems of Borneo, there is still considerable uncertainty, a fact which is made apparent by the topographical maps of the island. Several mountain ranges appear there which, radiating from a common centre, diverge in various directions—N.W., N.E., E., S.E., and S.W. But this method of representation is not universal; for instance, in Wettstein's map of Borneo all the chief mountain ranges have, on the whole, a north-easterly direction. But even the system usually adopted of representing the chief mountain chains by radiating branching lines does not correspond with fact; for, as far as we at present know, uninterrupted mountain chains do not exist. There are simply a number of larger or smaller mountain islands, extended mountain ridges, isolated mountain cores, and single mountain peaks, which, surrounded more or less by an undulating country, follow one another in the direction of the imaginary mountain chains. The mountain chains marked in the maps indicate properly only the lines of water-parting between the river basins in the south and west of the island, and on the north and east coast. The reason why the mountain ranges are always represented on the topographical maps of Borneo as branching in a radial manner arises from the absence of reliable details; and when mention is made in the sequel of the chief mountain chains, this is simply done for convenient generalization.[1]

The cause of the scantiness of information respecting the mountain systems is explained by the small number of travels that have up to the present been made in the interior of the island. Few travellers have ventured to the foot of the mountainous districts, or have crossed the mountain chains.

---

[1] An exception is the territory of the British North Borneo Company, where in late years much exploration has been undertaken.

Their tectonic structure is only known in a few places. The descriptions of observers in the different districts are, however, so uniform, that from them a similar structure may be inferred, with some degree of certainty, for the mountains as yet unknown. Everywhere short ranges and isolated groups of hills rise from the plain like islands from the sea.

The Central Mountains.

According to the information at present available, the existence of a central group of mountains, from which all the larger rivers take their source—the Barito in the south, the Kapuas in the west, the Redjang in the north, the Mahakkam in the east—appears to be certain. It is to be regretted that these central mountains have not yet been examined. Only one traveller has traversed this district. This was G. Müller, by birth a German, in the Dutch-Indian civil service. Starting from Kutei on the east coast, he attempted, in the year 1825, to traverse the island from east to west, after a similar attempt from the west had failed. Travelling up the river Mahakkam, he had already crossed the divide, and penetrated into the basin of the western Kapuas,[1] when he was murdered by a hostile tribe. Unfortunately his maps were lost.

Dr. Schwaner, a German, in the service of the Dutch-Indian government, came, in the course of his travels in the forties, into the neighbourhood of the central mountains of the upper basins of the river Barito, and his description, based to a large extent on the information of the natives, is the only one we possess.[2] In forties H. von Dewall, also in the Indian civil service, laid before the Indian

[1] The Western Kapuas, as there is a river of the same name in the south of the island.

[2] Henrici and Horner (both Germans, in the service of the Indian government), reached the upper basin of the river Barito; but we get no information from them concerning the central mountain chain.

government a plan, by which he proposed to explore the central mountains; but his intention was never put into execution, a fact which, in the interests of science, is to be regretted. This central mountain chain of Borneo, lying between 10° 20′ and 2° 20′ north latitude from Greenwich, consists, according to Schwaner, of a mountain mass running W. and S., the highest peaks of which are the Gunong Tebang and the G. Apo Borau.[1] From this mountain mass radiate the chains forming the divides, and thus constitute the ribs of Borneo, which separate the island into four chief subdivisions, N., E., S., and W.[2]

The Gunong Tebang is well known to the natives. Both Schwaner and von Dewall were told by those in the interior of Kutei that further inland a very high mountain—Tebang—existed, in which all the large rivers of the island took their source; further, that this mountain was so high that it nearly reached heaven, and that its summit was always white (snow?). Similarly Burns, in his "Travels in North Borneo," mentions that towards the interior the hills gradually swell into the high mountain Tebang, in which all the large rivers take their source. The natives in the upper districts of the R. Redjang also told the Italian naturalist of the Gunong Tebang, in which the four great rivers of Borneo took their source. Crocker also mentions the occurrence of a very high mountain, the Tebang or Tedong, in the interior of the island, in which the great rivers take their source.

That there exists in the interior of Borneo a central chain of mountains in which the rivers Barito, Kapuas, Redjang, and Mahakkam rise, is made probable by the agreement in the accounts given by the natives in the different parts of the interior of the island; but, with regard to the extent,

---

[1] On Dornseifen's map Baring is given instead of Apo Boraw.

[2] According to Dr. J. Dornseifen's Atlas van Nederlandsch-Oost en West Indië, 1884. On Schwaner's sketch of the chief watersheds in Central Borneo (Borneo), the geographical latitude and longitude are not given.

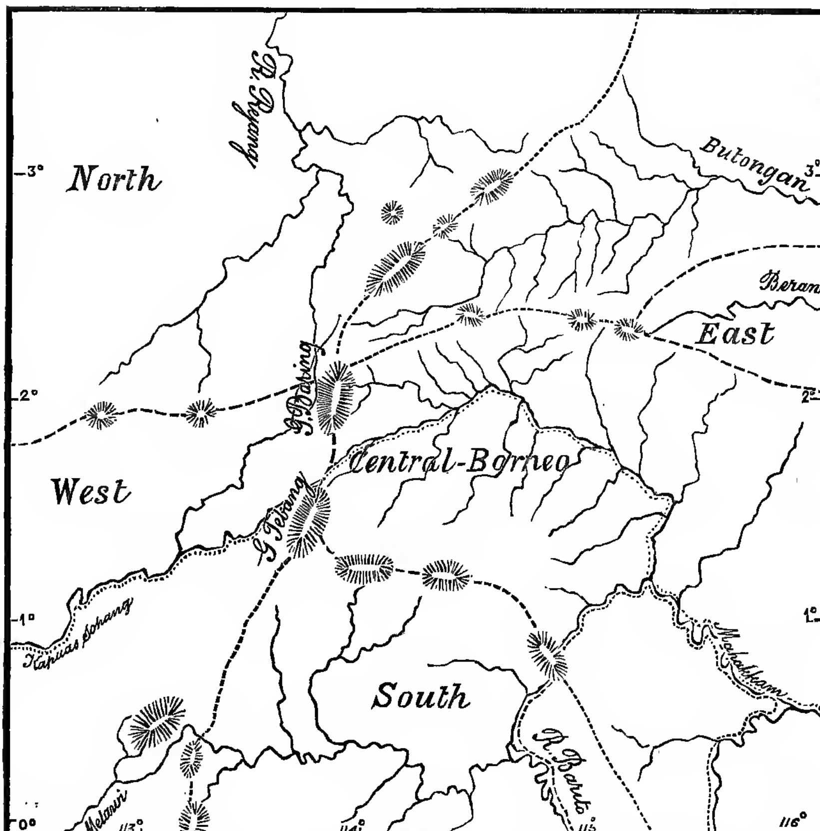
height, etc., of these mountains, the statements are very variable. While the natives of central Kutei (east coast) assert that the Gunong[1] Tebang are immense mountains, reaching nearly to the sky, the traveller Beccari was informed that in the interior of Sarawak no great mountains existed, that the G. Tebang was not higher than 5,000 feet, that in a day's journey one could get from the basin of the R. Redjang to that of the other rivers, and that it was possible to travel from Brunei, in the north, to Pontianak, in the west, or to Bandjermassin, in the south, almost without leaving the water. Everyone who has lived in colonial countries knows what is the value of the statements of natives; and it often remains uncertain how much of that which is related is correct, and how much is exaggerated or invented. Taking the statements in this case as correct, the different accounts agree very well with one another. The assumption is not improbable that the natives, in the east and in the north, only knew isolated parts of the same mountain mass, which has a different aspect near the frontier of Kutei to what it presents in the upper districts of the R. Redjang. Perhaps only the spurs of the central mountains were known to the natives of the north, while those of the interior of Kutei were acquainted with the main mass or mountain core itself, hence the conflicting statements. From the central mountains the four chief mountain ranges branch off, stretching towards the N.E., S.E., S.W., and N.W., and forming the political boundaries. As they bear no particular names,[2] we will call them by those of the districts they divide, whereby their main positions will be also given. Thus, the north-eastern mountain chain separates North from East Borneo, and runs in a north-

[1] "Gunong" means mountain, but is also used for peak, chain, and *massif;* lower elevations are indicated by the word, Bukit (hill).

[2] The natives give proper names only to parts of mountains, they have no name for the whole chain.

easterly direction. The south-western chain comprises the mountains separating South from West Borneo, and runs in a south-westerly direction. The eastern mountain chain stretches through the middle of East Borneo, separating Kutei from the northern states. How A. von Schweiger Lerchenfeld came to name the mountain ridge extending eastward from the central core, the Sakaru chain; that, stretching out to the south-east, the Louang chain; and the mountains extending to the south-

WATER-PARTINGS IN CENTRAL BORNEO.



-.-.-.-.-.-. Schwaner's Route. .... G. Müller's Route.
– – – – – – – – – – – Line of Water-parting.

west, the Crystal Mountains (Batang-Lupar), is not clear: I find nothing of the sort mentioned in the literature or on the maps. The Gunong Sakaru and Louang only denote single mountain ridges, and the same is the case with the Batang-Lupar mountains.

South-Eastern Mountain Chain[1] (the Divide).

This mountain chain forms a curve open towards the west. Its central part strikes to the south-east, to about 1° 30′ south latitude. Then after running several miles from north to south, it finally turns more and more towards the west; so that in the most southern part (in Tanah-Laut) the Meratus mountains assume a south-west by southerly and north-east by northerly direction.

In their geotectonic relations the single parts present considerable differences. The mountainous character is most pronounced in the central parts of Tanah-Laut. Large isolated mountain masses and short mountain ridges rise up like islands from the surrounding hill-land. In the northern and southern districts these mountain-islands are extensively developed, and reach a considerable height, but the middle parts of the chain consist of hill-land, from which only isolated peaks rise up. The south-eastern mountain chain slopes towards the south, but near its termination it rises again into mountain masses. Schwaner[2] describes the northern central part of the mountain chain thus:— "On the north, the mountain Batu-Bundang reaches its greatest height in a peak of 4,500 feet, situated in 0° 36′ north latitude and 114° 36′ east longitude. This mountain

---

[1] This divide was traversed in three places: at 0° 50′ N. latitude by Schwaner; at 0° 10′ N. latitude by the same traveller and Carl Bock; 1° 30′ S. latitude by Von Dewall. Respecting this chain Schwaner gives the most information, then Horner, Von Dewall, and in Tanah-Laut, numerous observers, as Horner, Schwaner, Verbeek, Hooze.

[2] Schwaner, S. 16, vol. i. pp. 3 and 4.

is a serrated ridge, extending N.N.E. and S.S.W., and terminated at its S.S.W. extremity by a steep inaccessible rocky wall, which is at the same time its highest point. On the east it is continued by a few unimportant hills, while on the south-east, it joins the Gunong Toho, a mountain ridge, extending in an easterly direction to 0° 20′ north latitude, and forming the boundary of the mountain-land in this direction, for it is surrounded by hill-land, through which only a few solitary peaks protrude to attract the attention of the traveller. On the west, the G. Batu Bundang is connected by a range of high rounded hills with a series of mountain chains, extending in a S.W. and S. direction. These chains send off numerous spurs, and are characterized by their peculiar form: steep mountain ridges, perpendicular rocky walls, resembling ruins, and steep summits, being peculiar to this mountain-land. Between the heights we find plateaus extending over several English miles. The principal mountains are,—Bukit Sakka, Batu Maliko, Gunong Mantulu, G. Klumbai, and G. Kapok. In a westerly direction these ranges are followed by other similar ones, forming on the south the divides between the different tributaries of the river Barito. All run in a south-westerly and southerly direction, some reaching a considerable height, *e.g.*, the G. Menangin and Njerobungan. As we proceed towards the west the mountains become higher, and the district assumes more and more the character of a wild mountain-land. North of the G. Batu-Bundang, as far as the eye can reach, it sees only a low hilly country alternating with marshes, while on the north-west, towards the central mountains, larger mountains are again seen; for instance, the Batang Lisong and Batu Andai,[1] forming part of the divide." The more hilly part of the mountain chain extends from 0° 20′ north latitude to about 2° 10′

[1] Marked on the map as Batu Lesong and Batu Antau.

south latitude. The boundary of the provinces of Kutei and Passir on the east coast, consists almost entirely of hill-land, and from this hill-land rise up more or less isolated mountain ridges or peaks, as for instance, the Gunong Taing Bong striking west south-westerly, between the river districts of the Teweh and Lahay; further, the G. Rassan Hudak, 340 metres high, and the G. Taing Kopang, 200 metres high on the south. Other smaller mountain ridges follow, extending in a direction parallel with the water-parting, such as the G. Melihat and G. Kramu,[1] striking north and south in the frontier districts of Passir. According to Von Dewall, the frontier mountains of Passir do not form an unbroken line, but are composed of isolated mountain chains.

From 2° 30′ south latitude (or rather, from 2° 10′ south latitude, since the mountains extend as far as the neighbourhood of Amunthai), the frontier country loses its hilly character, and higher mountains again appear, extending to the end of the mountain chain. This part is called the Meratus Mountains, and is composed of the following groups, counting from north to south:—Pramassan Alai (about 3,000 feet high, according to some estimates), Pramassan Amandit, and Tanah-Laut. The last-named is composed of a number of parallel ridges, extending in a south-westerly by southerly direction. The most western mass is the Gunong Bobaris, forming the divide between the rivers Riam Kiwah and Riam Kanan (or Batu Api and Karang-Intan). All these mountains are connected by hill-land.

The Gunong Bobaris, running N.E. by E., and S.W. by W., is composed of a series of mountain ridges and peaks, lying almost in a straight line. The summits are as follows:—Pempuron I., Pempuron II., Tiwaan, Bukit Melatti, Plawangan, Batarah Bulu, Bukit Besar, and Pamat-

[1] Weddik E. 3.

ton. The height of these varies from 800–1,200 feet, and the highest point, Bukit Melatti, according to Verbeek, is not more than 1,600[1] feet. On the south-west the hill-land appears again, with isolated mountains—for instance, the G. Lumut and the G. Tamban, which is 1,800 feet high. On the south-west the Gunong Bobaris gradually slopes away, and on the north-east unites with the chief chain, the Ratus or Meratus Mountains.[2] The G. Sakumbang, ascended by G. Müller, reaches a height of 967 metres.[3] Spurs of the south-easterly mountain-chains are sent off to the east and west. While the G. Bobaris should, properly speaking, be classed with the western secondary chains, others also exist. Thus, between the rivers Tabalong Kiri and Kanan, there is a secondary chain, with "peculiar wall-like, serrated peaks, resembling distant castles," with the conical G. Kasala, 2,000 feet high, in the background.[4] Of the eastern spurs, the secondary chain, which forms the boundary between the provinces Kutei and Passir, must be mentioned. This chain branches off from G. Katam, the main chain, and runs in a south-easterly direction towards the coast. Looking from the Bay of Adang towards the north, the Balik Paparo, the highest peak, is seen rising from a slightly undulating hill-land. It is 1,600 metres high, and "is shaped like the parapet of a redoubt." Nothing has been written with regard to secondary chains in the states of Tanah-Bumbu, Kusan, etc. With the eastern secondary chains should be classed the south-westerly mountainous parts of the island of Laut (Pulu Laut); but we are in possession of no details, except that it runs in a direction parallel to the rest of the mountain chains.

---

[1] According to Schwaner's older estimation Pempuron (Schwaner writes Bamburon) is the highest mountain, viz., 2,500′.

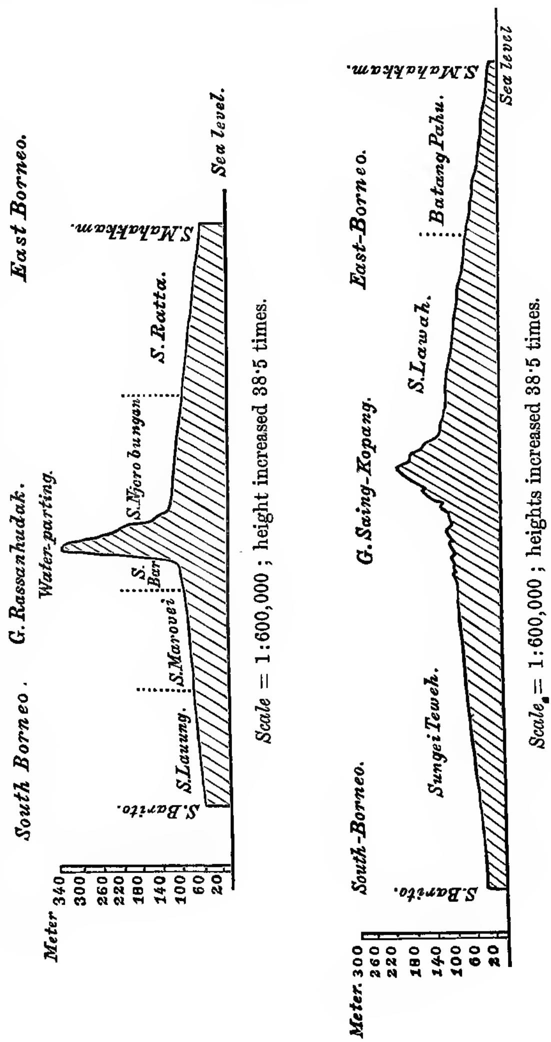
[2] In English "the Hundred-mountains"; S. Horner S. 1; Schwaner S. 15, I. 54 and 55; Verbeek S. 36, p. 14.

[3] Verbeek S. 41, p. 15.

[4] Grabowsky S. 52, p. 446.

With regard to the south-eastern mountain-chain, we notice the following peculiarities:—the presence of mountain islands in the hill-land; the mountainous character of the central and peripheral parts; the predominant hilly nature of the intermediate parts; and the general north-east and south-westerly strike, with slight variations, of the separate mountain islands and secondary chains.

SCHWANER'S SECTION THROUGH THE SOUTH-EASTERN WATERSHED (AFTER SCHWANER).



South-Western Mountain Chain.[1]

This chain extends from the central mountains chiefly in a south-western direction, ending near Cape Sambar, the south-western extremity of the island, at a point from six to ten geographical miles distant from the coast. It forms the boundary between the Residencies of South and West Borneo. This chain retains its mountainous character almost throughout, the hill-land being very subordinate. It appears to widen towards the S.W., forming a greatly extended mountain-land in the upper river basins of the Katingan, Pembuan, Kottaringin, and of the tributaries of the Melahui. The central[2] part has a more hilly character, being composed of subordinate mountain ridges, above which rise a few high mountain masses lying at great intervals along the line of water-parting, the intervening space being bridged by lower ranges of hills. The remaining part has an alpine character.

The district lying between the sources of the R. Melui in West Borneo, those of the R. Kahajan, and the Sungei Djoloi (one of the sources of the Barito), is called by the natives G. Kaminting.[3] This name, however, cannot be applied to the whole mountain range, as Schwaner points out.[4]

From the mountain called Pohon Batu, a rocky ridge 400 feet high, in the upper Kahajan river basin, Schwaner describes a view extending over the district for about twenty English miles.[5] The land rises to higher and more connected ranges of mountains, which extend in parallel

[1] The description is taken chiefly from Schwaner; the S.W. part from Von Gaffron. The mountain chain was crossed in two places: by Von Gaffron at about 1° 10′ south latitude, and 111° 10′ east longitude, and by Schwaner at 0° 40′ south latitude, and 112° 10′ east longitude.

[2] Ib. I. p. 1 and 2.

[3] Ib. I. p. 9; II. p. 67–69.

[4] Ib. II. p. 69.

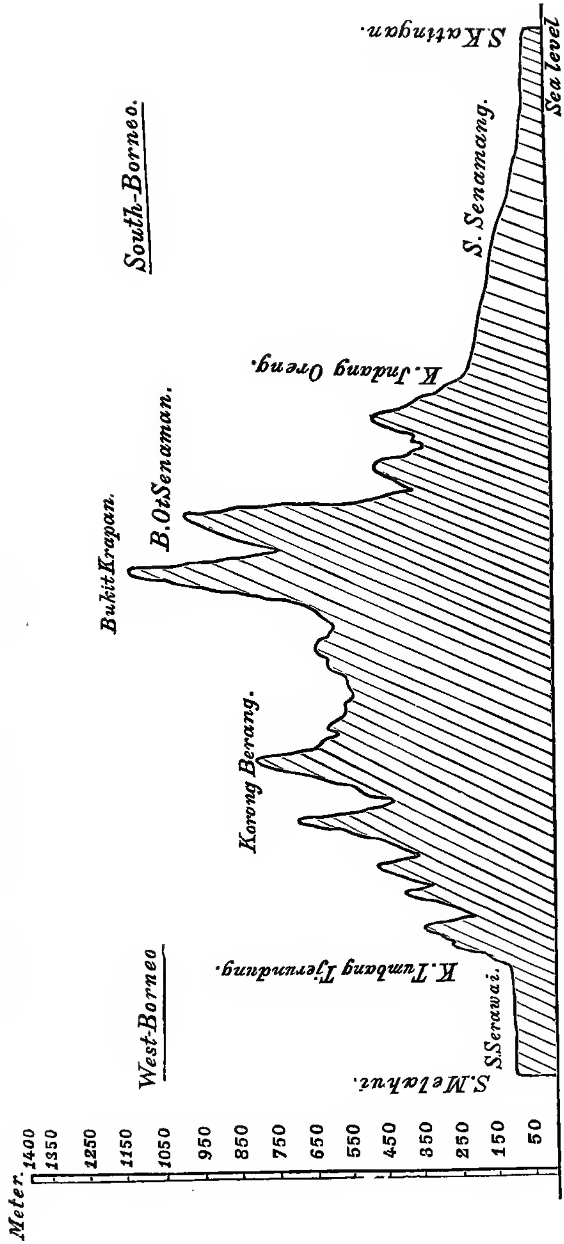
[5] Ib. 16, II. p. 59.

lines in a N.E. and S.W. direction, and seem higher the more distant they are. Looking to the west only ranges of small hills are seen. On the north-west, north and north-east, however, all is mountainous. In that direction lie the five-fold serrated Njatu mountain, 2,500 feet high, the saddle-formed Menjarn, the elongated Njero Bungan, etc. A very fine view of these mountains is obtained from the river Senemang, a tributary of the R. Katingan. Michielsen[1] describes it from Tumbang Kantjikan thus:—"From a chaotic assemblage of hills rise a few sharp-pointed peaks. From the western to the north-eastern points of the horizon, there extends an extensive mass of mountains, the summits of which are wrapt in clouds. To the north lies the Rajah Bukit (king of mountains), the Olympus of the Dyaks, being the highest peak in the whole mountain chain, 7,000–8,000 feet high." It is composed of light-coloured rocks; and on one side there is a small but very deep lake, enclosed by steep cliffs. The summit of the mountain is said to occupy an area of 200 square feet.[2] Schwaner, who crossed these mountains from the R. Senemang, reached, at Indang-Oreng, the foot of a high extended chain of mountains, striking west north-west by east south-east.[3] He says:—"We should be wrong in thinking that this is a connected mountain chain, the chief line of strike of which is determined by means of the highest peaks, while the mountain declivities die away uniformly towards the north and south. This is not the case. There is neither a mountain ridge nor a sharply-cut base. It is a mountainous plateau of 20–30 English miles width, intersected by valleys and fissures in all directions.

---

[1] Michielsen S. 46. [2] Schwaner S. 16, II. p. 123.
[3] Ib. II. p. 68 and 171.

Schwaner's Section across the S. W. Boundary Mountains (after Schwaner).



Scale = 1:80,000; height increased four times.

From it rise numerous isolated mountains, between which are narrow ravine-like valleys separated from one another by dry or marshy terraces. These isolated mountains lie irregularly distributed over the plateau, and the highest peaks are for the most part not in the longitudinal axis. The separate mountains seldom coalese to mountain chains; and their ridges generally present extraordinary forms and deeply-cut saddles. It is an alpine region of a desolate character, and possesses no general designation, each mountain having its own name" . . . and, further:—"We crossed a zone of the mountain-land extending over forty-seven English miles, from the mouth of the Tenemang on the south, to the mouth of the Tjerundong on the north, and saw that the plateau sank towards the south, by short successive steps, as in the north. Steep mountain declivities bound the plateaus, on the northern boundary of which deep steps are again found, until at last the terraces[1] melt away into the common level. This regular terrace-like formation is interrupted by isolated individuals or groups of mountains, the peaks of which do not generally lie in the main direction of the divide."

From Melahui (West Borneo) Schwaner, after having crossed the chain, again saw the boundary mountains:—"From here they appeared as a range of closely connected mountains, above which towered some higher peaks."[2] The south-westerly part of the mountain chain explored and crossed by Von Gaffron[3] presents a similar character. The chief chain, striking north-east, is not continuous, but consists of separate ranges.[4] The mountains are grouped

---

[1] Characterized by marshes.

[2] Schwaner S. 16, II. 181.

[3] Von Gaffron S. 27.

[4] Unfortunately we possess no description of his passage over the mountain. His four works were not published by himself, but in a short summary by Pynappel.

so as to give the country a saddle-like appearance. "One cannot resist the impression," says Von Gaffron, "that formerly there existed here (Katingan), as in the remaining parts of South-west Borneo, a great number of islands which became connected by the accumulation of the drift." The spurs of the south-western mountain chain in the states of Matan, Sukadana, Kottaringin, form only isolated mountains, or mountain ridges, often of unimportant height, scattered over the hill-land, *e.g.*, the Gunong Palong, Koman Bajor, Sablangan, Malaju, Betong. They are separated from the coast mainly by alluvial formations to the extent of from six to ten geographical miles. But we also find outliers on the coast; and most of the neighbouring island groups are also mountainous.[1]

This chain also sends off many secondary spurs, which separate the river basins.[2] Thus, a secondary chain extends from the G. Sambayang towards the south, forming the water-parting between the rivers Djelei and Kottaringin. A second subordinate chain extends between the rivers Arut and Pembuang, the highest peak of which is the Mountain Lantjau, 3,800 feet high. There are also lower chains between the other river basins, among which are the mountains forming the watershed between the Barito and the Kapuas. The G. Pararawen[3] seems to possess a more independent character. It is a ridge, which, for the most part, extends in a southern direction, and includes the most southern mountain-island in South Borneo. Its summit (about 800 feet) with its two peaks—Bini and Laki—(man and wife), striking north and south by south-west, is elevated above the surrounding hill-land, and, seen from Teweh, presents a very fine view, as I

[1] Everwyn W. 39.

[2] Von Gaffron, S. 27.

[3] This ridge was ascended by Schwaner in the forties, and by Posewitz in 1882.

have often had the opportunity of observing.[1] Many secondary chains make their appearance on the northern side of the mountain chain (in West Borneo). They extend as far as the left bank of the R. Kapuas.

The mountains forming the divide between the rivers Melawi and Kapuas (in West Borneo) are more isolated.[2] This chain seems to be tolerably high, reaching a height of 3,000 feet above the sea-level. Schwaner saw it as a great mass, its peaks plunged in the clouds. Some parts of it are more developed and bear distinc-ctive names. The beginning of the mountain chain in the central states is called Gunong Gemba; another part, Gunong Penai; while the highest elevation bears the name Gunong Lian. Further there are the Gunong Alat, the Batu Balla Kapalla, and the Bala Rumpi. The chain extends for the most part in a north-eastern and south-westerly direction, rising higher towards the interior of the island, but dying away towards the junction of the rivers Melabui and Kapuas. At the latter place it forms, as it were, the outlying spurs of the isolated and steep Gunong Klam, whose high but short ridge, with steep rocky precipices, rise abruptly from the surrounding low-land. Whether this range forms a separate mountain-island, or is connected with the central mountains, is not yet known.

The mountains between the Sekadau and the sources of the rivers Pawan and Meliau have the same independent character, and, according to G. Müller's opinion, formed at one time the heart of an island separated from the coast of Borneo by an arm of the sea, but later on connected by the accumulated drift.[3]

Thus we have in the south-western mountain chain the same character as in the eastern, namely, a general north-

---

[1] Posewitz S. 51.
[2] Schwaner S. 16, II. p. 181, 187, 190.
[3] G. Müller W. 2, p. 260, 285; Veth, p. 6.

east and south-westerly strike of the separate mountain chains, and an aggregation of isolated mountain islands.

THE MOUNTAIN-CHAIN FORMING THE NORTHERN WATERSHED.

This mountain chain, which is composed of north-western and north-eastern branches, is, for the greater part, less known than the two mountain chains already described.[1] If we include the large mountain mass of Kina-balu, the general direction of these mountains is north-east and south-west; only the south-western part (West Sarawak), strikes north-west and south-east, forming in consequence a curve towards the coast open to the north-west. The height of these mountain chains is very varied. The highest of them all in the north-east of the island is Kina-balu, which rises to an elevation of 13,698 feet. In the middle this mountain is not so high, its peaks varying from 6,000 to 8,000 feet. The spurs of the chain in the north-west, forming the frontier between Sarawak and West Borneo, appear to be still lower, the peaks of this part being only from 2,000 to 3,000 feet high.[2] The chain is terminated by the Datu mountains, running north and south, the spurs of which reach the sea, forming the Capes of Api and Datu. Isolated peaks, such as the G. Pallo (2,000 feet), G. Kewai, G. Brooke, and G. Pol (6,000 feet), form important elevations.[3]

This boundary chain runs parallel with the coast at a distance of about 160 kilometres;[4] but it is not continuous, being composed of isolated mountain islands, long extended mountain ridges, and separated mountain masses, presenting

[1] Notes by Crocker, Ida Pfeiffer, St. John, Hugh Low, Beccari, Hatton, and Van Schelle. The boundary mountains between Sarawak and West Borneo were traversed by Ida Pfeiffer, in 1852, at about 113° east longitude; Beccari followed the same path (N. 12, p. 203); he estimated the height of the chain at 1,200′, and the lowest height at 300–400′.

[2] Low N. 1.

[3] Le Monnier N. 40, p. 452.

[4] Antoine N. 38, p. 691.

the same character as the south-western chain,[1]—*i.e.*, it widens towards its termination, forming in Sarawak and Sambas, an extensive mountain land. Some parts of it have distinct names, as the G. Klinkang, G. Batang-Lupar, G. Saribu-Saratus, and G. Madei. The mountains forming the boundary between Sarawak and Sambas, called by the natives of Sambas, Gunong Brunei,[2] are, as before mentioned, rather low. To the north of the G. Penrissan they only reach a height of from 280 to 300 metres above sea-level, and are of inconsiderable breadth. The chain is continuous from Cape Datu to Simingit, 113° east longitude.[3]

Ida Pfeiffer[4] describes the passage over these mountains as follows:—"The road led constantly through narrow valleys and through an unbroken line of marshes and rivers, in which one had to wade up to the knees. From time to time we had the view of a three-fold range of mountains in which one ridge rose behind the other, intersected by valleys through which rivers flowed." Beccari followed the same route, and he estimated the highest hill ranges at 1,200 feet, and the lowest at from 300 to 400 feet. That this boundary land consists only of isolated mountain masses, is also proved by Crocker, who, in travelling to the west of the G. Saribu-Saratus from the north (Sarawak) of the river Batang-Lupar to West Borneo, in the neighbourhood of Lake Seriang, traversed only flat land.[5] We know almost nothing of the further course of this mountain chain to the north-east, as this part of Borneo is still a *terra incognita.* The only exception is St. John,[6] who, during his journeys to the interior of Brunei, when travelling up the river Limbang, approached the northern mountain chain. But he only mentions its height, which he puts at 7,000 to 8,000 feet.

---

[1] Crocker N. 34.
[2] Van Schelle W. 56.
[3] Crocker N. 341, p. 201.
[4] Ida Pfeiffer W. 14.
[5] Crocker N. 34, p. 201.
[6] St. John N. 9.

H. von Dewall[1] describes the view of the mountain-land of the interior of Kutei from Djuk-Depok, situated on the river Mahakkam. He also saw only isolated ridges, and no connected chain. With the exception of one hill the whole country was mountainous. In the foreground, low hilly masses appeared; in the background, mountains were seen, the highest peak of which is the Belik Ajuk, 2,000 to 3,000 feet high, running north-east and south-west. Looking north by 5° east another mountain chain was visible, the highest peak of which is the Kong Tenong; and to the north by 39° west, at a great distance, the Batu-Tenwang mountains. On the south the hill-land forms the boundary between south and east, and separating the river basin of the Barito from that of the Mahakkam.

Better known to us is the great mountain island of Kina-balu (Chinese woman), 13,698 feet high, according to the trigonometrical determination made from the sea by the English admiralty. Kina-balu was first ascended by Hugh Low, the well-known botanist, in 1851.[2] The English naturalist, Lobb, in 1856, only got as far as a place called Kiang,[3] at the foot of the mountains, as the natives refused to go further. In 1858, Spenser St. John climbed the southern peak; and in the same year, together with Low, reached the highest point from the river Tampassuk.[4] In 1873, Giordano, Bove, and Bocca, attempted to scale the mountain, but only reached the outlying spurs. In 1882, F. Hatton climbed a peak of this mountain, 7,000 feet high, resembling the Matterhorn.[5] In 1887, R. M. Little, a civil officer of the British North Borneo Company, climbed Kina-balu from Tuaran to Kian, following the route that St. John had

[1] Weddik O. 3.

[2] He climbed it three times.

[3] Bove N. 20, p. 272.

[4] Low was obliged to remain behind on account of his injured foot (St. John N. 10, p. 218).

[5] Hasson N. 48, p. 79.

taken twenty-nine years previously, along the river Tampassuk (= Kadamagan in its upper course).[1] He, however, did not reach the highest peak. About ten peaks stand in a line running east and west; while an isolated peak rises on the south, separated from the others by a deep, wide, terrace. It is not known which of the peaks is the highest, as barometric measurements have not yet been made; but the southern peak seems to be fifty feet lower than the others. The western peak appears to be rounded, and its northern slope is covered with large boulders. Between this and the eastern point, on the edge of the deep precipice, there is a wall of immense granite blocks, piled up as if by human hand. On three sides of this there are such deep abysses, that the eye cannot fathom them. The view from the peak is magnificent, according to St. John. The coast line is visible as far as Labuan. To the south and south-east appear numerous mountain chains and mountains from 7,000 to 8,000 feet high. Between these mountains and Kinabalu lies a grassy plateau about eighteen miles distant.

Kina-balu, which is the highest mountain in the whole of Borneo, sends out chains in every direction, which again subdivide. The most important of them run in a north-western and north-west by northerly direction. On the west they are only 5,000 feet high. On the south-west there are two mountain chains, of which the western one again divides while the eastern appears to be the most important of all. It turns first to the south-west, but takes later on a south-west by southerly direction for more than twenty miles, at the same time subdividing into numerous branches. The outlying spurs rise, with few exceptions, steeply from the plain. The first range, which is connected by cross ranges with those lying further inland, has a height of 3,000 feet; those behind, 6,000 to 7,000 feet. The physiognomy of the

---

[1] *British North Borneo Herald*, 1887, No. 7.

landscape has an Alpine character.[1] The general strike of this large mountain-island is north-east and south-west. Witti mentions, indirectly, that Kina-balu is an independent mountain-island; and, according to his account, the central chain in the north-east of the island strikes to the east (south of Kina-balu), and is not connected with this mountain.[2]

We know very little respecting the course of the secondary chains on the north-east coast. The mountain or hill-land extends in many places as far as the coast. Thus, in the background of the Bay of Darvel, the Silam mountains reach an altitude of 3,000 feet, and high mountains occur in the Bay of Sibuco.[3] The smaller mountain chains in the Chinese districts are southern spurs of the northern mountain chain between Sarawak and West Borneo. Many hill-ranges of varying heights lie in an undulating plain elevated ten to thirty metres above the sea-level, among which are four chief mountains—Bawan, 1,400 metres; Padan, 950 metres; Sanggau, 802 metres; and Skadau, 595 metres.

The strike of the mountains is either north-east and south-west, east and west, or north-west by south-east. Thus, the Skadau mountains strike north-east and south-west; the Pandan mountains, east and west, with its spurs G. Pandung (950 metres), Bani (569 metres), Lo-sin-Keu (496·4 metres), and Mankong (735 metres high). The Udu mountains strike east and west, and the steep Hang-Ui-San mountains, north-east by north, and south-west by south.

The peculiar mountain structure of Borneo,—namely, isolated mountain ridges and mountain islands lying in hill-land, is also evidenced here. The spurs are separated from the coast by alluvial tracts, but, as in Sukadana, outlying spurs also occur near the shore, and many of the

---

[1] St. John N. 8 and N. 10; Le Monnier N. 40.

[2] Witti's Journal N. 41.

[3] Le Monnier N. 40, p. 548.

neighbouring islands have a mountainous character: *e.g.*, G. Pamangkat, Tandjong Gunong, T. Badjau, Batu Blad, T. Bangké.[1]

The Skadau mountains may serve here as a type of the prevalent mountain structure. The mountain mass proper is composed of three high mountain ridges: a central steep mountain chain, the highest peak of which is the Skadau; the lower Pekaka mountains; and several isolated steep mountains spreading out in a south-easterly direction. These higher parts are connected by hill-land. Their spurs, too, are low, and sloping gradually, lose themselves in the surrounding plains.

Some isolated mountain ridges and peaks which extend as far as the coast of Sarawak, may be regarded as northern spurs of the northern mountain chain between Sarawak and Sambas. In the interior of Sarawak proper are the Bongo mountains (3,000 feet high), the Seraung mountain ridge (2,027 feet high), and mount Penrissan (4,700 feet). The Matang mountains (3,168 feet), the G. Santubong (2,712 feet), Cape Po (Po Point), approach nearer the coast, both the last-named being at the mouth of the river Sarawak.

Further towards the west, in the district of the sources of the river Sadong, are the mountains Sepudang (4,000 feet), Siboran (4,000 feet), and Tulek (3,500 feet high); and still further the Klinkong mountains forming the boundary. A mountain chain extends towards the coast as far as Marup, on the Batang-Lupar, with the mountain Tian Ladju, 3,000 feet high, which was ascended by Beccari in 1866.[2] A second spur separates the districts of the rivers Batang-Lupar and Redjang, and some isolated mountains, among which is the G. Ular Bolo, 3,000 feet high, occur to the east of the river Redjang, occasionally approaching the coast. Becarri estimated the hill-land traversed by him in the

---

[1] Van Schelle W. 50, p. 6 and 24; Ib. W. 63, p. 280; Ib. W. 69, p. 119.

[2] Le Monnier N. 40, p. 473.

middle river districts of the Bintulu, Redjang, Sakarang, Entabei, and Linggang, at a few hundred feet.[1]

Eastern Mountain Chain.[2]

This mountain chain, the least known of the four, runs from the central mountains towards the east coast in a more or less easterly direction, and terminates near Cape Mangkalihat. We know but little concerning its formation, as H. von Dewall is the only traveller who has visited (in 1849) those states, and then only the districts in the vicinity of the coast. Equally little is known of the secondary chains which separate the river basins: the largest of them divides the rivers Bulongan and Beran; but high mountains appear to exist in the interior of these states, thus the highland of Berau is estimated at 3,000 feet.[3] These districts are among the least known of Borneo.

The following are the names and heights in feet of the central mountains,[4] estimated at 5,000–6,000 feet.[5]

1. South-eastern Chain,[6]

District of Tanah-Laut.

	Feet.		Feet.
Meratus, -- --	4,250	Belarong, -- --	2,200
Sakumbang, -- --	4,250	Padakan-benau, --	1,400
Satui, -- --	4,200	Krameang, -- --	800
Kintap, -- --	4,300	Gold Mine Pontain --	900
Batu-gapit, -- --	3,500	Pass over the mountains,	1,120
Lanopon, -- --	2,400	Batu Kuruh, -- --	1,360

---

[1] Beccari N. 12.

[2] H. von Dewall has explored a part of these districts, and we have him to thank for our information. It is a pity that his Journal, like Von Gaffron's, was not published, except in abstract (E. 6 and E. 7).

[3] Hagemann E. 7.

[4] The heights in 1 and 2 are taken from H. von Gaffron's Geological Map of the Southern part of Borneo, in J. v/h. N. I., 1882, II.

[5] Melville de Carnbée B. 3, and Hooze E. 13.

[6] According to Melville de Carnbée 3,400′.

State of Bandjermassin.

	Feet.		Feet.
Bobaris, ..	about 2,250	Ripi, ...	1,200
Damban (Secondary chain),[1]	2,000	Pomaton, ...	850
Paring, ...	1,700	Grabulu, ...	920
Batu laki, ...	1,230	Pengaron, ...	283
Bukit besar, ...	1,100		

Eastern G. Meratus.

	Feet.		Feet.
Melihat=Batu manok,[2]	5,000 or 3,500	Melihat=Kuru, ..	3,200
,, Kinsu, ..	4,300	,, Pihan, ..	3,000
,, Kramu,[2] ..	1,500	,, Sau, ..	2,600
,, Bintang awei,	3,800	,, Lange-muntei,	2,300
,, Latong beloh,	3,600		

Upper Barito (Siang, Murung).

	Feet.		Feet.
Bundang, ..	about 4,000	Sebajang, ...	2,300
Pengahan, ...	2,500	Bahan, ...	900
Matawo, ...	2,500		

2. South-western Chain.

Katingan and Kahajan.

	Feet.		Feet.
Kaminting, ..	about 3,500	Asei, ...	2,900
Raja, ...	4,700	Rusa, ...	1,800
Basa, ...	3,900	Kaki, ...	800

Sampit.

	Feet.		Feet.
Kalong, ..	about 1,900	Kitas, ...	1,400
Satuweh, ...	1,700	Kuian, ...	250
Panjanbahan, ..	1,400		

Pembuan.

	Feet.		Feet.
Kumpang, ...	3,000	Kurungan-manok, ..	2,000
Klambu rusa, ..	3,500	Thamau, ...	.2,500
Lantjau, ...	3,800	Tabui, ...	—
Akub, ...	3,000	Kampong Nangka Timan,	786

[1] G. Tamban, according to Verbeek's estimation, 1,800′, S. 41.
[2] According to Von Dewall.

Kottaringin.

	Feet.		Feet.
Sembajang, -- --	4,360	Meranting, -- --	2,100
Bungar, -- --	3,300	Merundan, -- --	3,000
Sekumbang, -- --	4,100	Ampuan, -- --	3,000
Bulu-hantu, -- --	—	Klambu rusa, -- --	3,000
Pamaring Badak, --	—	Pass over the Pamaring Badak,	—
Batu hadji, -- --	1,900	Kampong Kandawangan,	780

Matan and Sukadana.

	Feet.		Feet.
Kelasi, --	about 1,780	Minton, -- --	1,000
Tomborawang, --	840	Netong, -- --	1,230
Malaja, -- --	1,100	Kramas, -- --	1,060

Chinese Districts.[1]

	Meters.		Meters.
Bawang, -- --	1,400	Sanggau, -- --	802
Pandau, -- --	950	Skadau, -- --	595

Pinoh, and along the Great Kapuas.

	Feet.		Feet.
Sambaju, --	about 3,000	Sekujau, -- --	2,700
Pendulangan, --	1,100	Galimau, -- --	1,800
Gading, -- --	2,600	Tiong Kandang, --	1,700
Kumpei, -- --	2,700	Nangka Ora, --	950
Klam, -- --	3,000		

3. Northern Chain.

Sarawak.

	Feet.		Feet.
Penrissan,[2] -- --	4,700	Santubong, -- --	2,712
Bongo, -- --	3,000	Subangan, -- --	1,430
Seraung, -- --	2,027	Pallo, -- --	2,000
Sibarang, -- --	4,000	Pu, -- --	6,000
Tulek, -- --	3,500	Ular Bulu, -- --	3,000
Matang, -- --	3,168		

Brunei.

	Feet.		Feet.
Silungen,[3] -- --	1,500	Baling, -- --	7,000
Lambir, -- --	1,550	Marud, -- --	8,000
Sagan, -- --	2,500	Kalio,[4] -- --	5,500
Malu, -- --	8,000	Baling,[4] -- --	7,000

[1] Van Schelle, J. v/h. M. 1884, II.
[2] St. John N. 9.
[3] Taken from "Map of North Borneo," by Crocker, N. 34.
[4] From a "Map of British North Borneo," by J. Hatton, in N. 48.

Sabah.

	Feet.		Feet.
Kina-balu,[1]	13,698	Madalon, ...	5,000
Tambuyukon, ...	7,000	Ponuntungan, ..	8,000
Nonohan, ...	8,000	Mentapok, ...	5,000

4. EASTERN CHAIN.

Sabah.[2]

			Feet.
Silam,[2]	3,000	Beling Ajuk,[3] ..	3,000
Batu Mayak,[2]	5,000	Mountains in the Berau Highlands,[4] ..	3,000
Senkulirang,[3] ..	1,000		

		Metres.
In the Interior.	Suikerbrood,[5]	596·4
	Suwara, ...	140·1
On the Coast.	Djumarang, ...	210·0
	Badjau, ...	265·4
	Tabellar, ...	174·5
	Samiroa, ...	127·7
	Batu Tempatung, ...	1,600·0
		Feet.
	Water-parting between Kutei and Berau, averages	2,000–3,000[6]
	Balik-Papan, ...	2,000

HYDROGRAPHICAL RELATIONS.

The principal water-parting is formed by the "central mountains" of Borneo, and the chief chains of these mountains determine for the most part the course of the rivers. On the south of the *massif* rises the river Barito; on the east the river Mahakkam; on the west the Kapuas-bohang; on

[1] According to R. M. Little's aneroid measurements, made in February, 1887, the highest point is 11,810 feet (= 3,600 metres), consequently, 1,888 feet less than hitherto assumed (admiralty measurements). *North Borneo Herald*, July, 1887.

[2] Fr. Hatton (map).

[3] Von Dewall E. 6.

[4] Hagemann E. 7.

[5] Schonn Santvoort E. 11 is the mean of several determinations, made from a surveying ship in the seventies.

[6] Hooze E. 13.

the north the Redjang; and on the north-east the Kayan, or Bulongan. Schwaner, whom we have to thank for this information, gives, in his work on "Borneo" (p. 16), a sketch of the chief water-partings, reproduced in a simplified form on[1] p. 97. These chief chains determine the four river basins of Borneo,—namely, those of the south, west, north, and east of the island.

(1) River-Basin of South Borneo.

This is the best-known,[2] and largest catchment-basin, since it embraces the greatest number of rivers. The largest of the rivers of South Borneo is the river Barito, rising in the central mountain mass. Its two arms, the rivers Belatong and Murong, soon unite, and after flowing for some distance in a north and south direction, turn in a direction west and east, until, near Bumbas, they hasten again in a southerly direction to the sea. Its lower course is known as the river Barito, but further inland it is called the Dusson, and in the district of Siang, the Murong. Its tributaries are very numerous. Among those rising in the central land are the Boboat, Soho, Bumbas, and Laming. The largest are those whose sources are to be sought in the south-eastern boundary mountains, such as the Lahay, Teweh, Montallat, Ajo, Karran and Pattai; then the large tributary, Negara, with its sub-tributaries, Tabalong, Kiri, and Kanan; further, the Bulongan, Alai and Amandit; finally the river Martapura, with its two arms the Riam Kiwa and Riam Kanan. The most important tributaries on the right bank are the Pendre and Limu, encircling the Pararawen mountains. The remaining are unimportant. The reason of this is, that the divide between

[1] The path communicating with the separate river basins, which are marked on Schwaner's sketch, are here omitted; so also the names of many of the tributary rivers and mountains.

[2] We have to thank Schwaner and Von Gaffron almost exclusively for our information.

the Barito and the Kapuas, lies at first almost in the middle between the two rivers, but further down-stream it gradually approaches the Barito.[1] According to Schwaner the length of the Barito is about 570 English miles. The width of the river at its mouth is 5,600 metres; at Kwala-andjaman (51 miles inland), it is 1,739 feet; at Buntok (105 miles), 750 feet; at Muara Teiveh (159 miles), 650 feet; at Bahan (180 miles), 450 feet. Its inclination from Bahan to Buntok is 0·084 feet in a 1,000; from Buntok to its mouth, 0·048 feet in a 1,000.[2]

The river is navigable for more than fifty-three geographical miles, the first cataract making its appearance below Montallat. Its tributary, the Negara, is navigable as far as Amunthei. The extent to which navigation can be carried on depends chiefly upon the height of the water. Thus, for instance, the Negara is at times unnavigable as far as Amunthei; while a reef lying across the bed of the Barito, near Montallat, prevents all further navigation during the dry season, which at other times is easily carried out.

The western neighbour of the Barito is the Kapuas-murung. It rises about ten geographical miles south of the Barito, in hill-land about 1,000 feet high. In its upper course it takes a north-westerly direction, like the other rivers of South Borneo; but afterwards turns to the south. Its chief tributaries are the Kawattan, Nawat, Hiang, Sirat, and Taren. About eight geographical miles above its union with the right arm of the Barito, at Kwala Kapuas, it receives the waters of another river, the Mandangei (right arm of the R. Menkatip). The width of the river at its mouth is 4,000 feet.[3]

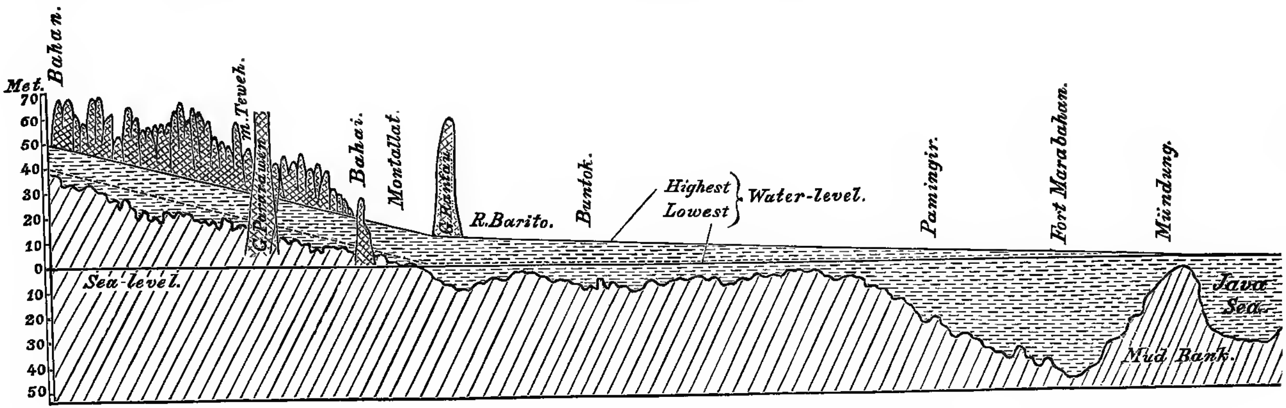
---

[1] Schwaner S. 16, I.

[2] Schwaner S. 9, and Aardrykskundige Aanteekeningen S. 30; see also map of R. Barito, from the mouth to the junction with the R. Martapura, near Menten, S. 48.

[3] Schwaner, Borneo I., S. 16, p. 17.

HORIZONTAL SECTION OF THE R. BARITO, FROM ITS MOUTH (MARKED *Mündung*) TO THE KAMPONG BAHAN (AFTER SCHWANER).



Scale = 1:4,000,000 ; heights increased 1,660 times.*

* It must be noted that this engraving has been reduced one-fifth from original.

The Kahajan rises in the same latitude as the Kapuas. Its largest tributary is the Rungan, which, in its upper course runs in a north-westerly and south-easterly direction, but turns to the south before hastening to the sea. The western rivers are: the Katingan, ninety geographical miles long, the most important tributaries of which are the Senemang and the Sampa; the Mentaja or Sampit, which is much shorter; the Pembuan, seventy-six geographical miles long; the Kurmei; the majestic R. Kotaringin, sixty geographical miles long, with its two large tributaries, the Arut and the Lamandan; and, lastly, the Djellei.[1]

A peculiarity of the rivers of South Borneo is, that the direction of their upper course is north-west and south-east. This is most striking in the eastern rivers, but gradually decreases towards the west. Later on the rivers turn to the south, and flow then in a direct course to the Java sea. The north-west and south-eastern course of the rivers is partly in mountain-land and partly in hill-land; the north and south course chiefly in the plains. In discussing the course of the rivers we can distinguish in general an *upper*, a *middle*, and a *lower* part, each of which has its own peculiarities.[2]

The upper course, down to where it enters the plains, is characterised by islands, formed of pebbles, and by cataracts. These occur as long as the rivers retain the north-west and south-east direction, but then disappear. In the middle course there are no islands; but here numerous lakes (*danau*) occur. In the lower course near the mouths, islands again occur; but these consist of mud.

The lake-formation, which stands in genetic connection with the so-called *antassans* and *trussans*, is worthy of a more detailed description. These terms signify a self-formed shortening of the great curves in which the rivers

---

[1] Von Gaffron S. 27.

[2] Schwaner S. 16, Borneo II., p. 29.

originally flowed. The first cause of this is to be sought in the annual floods. The water overflowing from its bed cuts itself a way through the surrounding plain, and collects in the deepest places. When the flood subsides, these places are deepened and enlarged. In the following year the same thing takes place. The water collects in the channel already formed, enlarges and deepens it; but at a certain depth the water remains constant in the new bed. The river itself often makes a *detour*, and if it meets with this river bed, a new arm is formed, which is generally much shorter, and furnishes a quicker passage for the water. This is the origin of the *antassans* and *trussans.* They are very welcome to the traveller, as they shorten his journey. The *antassans* are only found in the low-lying plains, and to a small extent have been made artificially, partly by digging a canal, partly by enlarging one of the naturally formed channels. Such artificial *antassans* are present in the R. Martapura, where the inhabitants are comparatively numerous, and the traffic is large. The largest natural *antassans* in the R. Barito are: the Baloi, Tallong, and Damu.[1]

To these we must also add the connecting channels, which frequently occur in the low-lying plains between the small rivers, and serve as a waterway in the rainy season. Thus the river Buntok is connected with the Limbing, the Bayor with the Ajo,[2] etc. The lake formation is connected with the *antassans.* During the formation of a new river arm, the old one sometimes gets filled up: the quantity of water diminishes, and the old river course becomes sluggish, so as to enable masses of mud deposit to collect. From the tributary streams the river receives a fresh supply, and, overflowing its banks, forms marshes, being unable to carry off in the new channel as much water as it receives. The lake produced in this manner receives a fresh supply from the streams formed during the rainy season.

---

[1] Schwaner S. 16, Borneo I., p. 19. [2] Ib., p. 22.

The lakes (*danaus*) are very numerous along the rivers, and are often connected with each other by small channels, which, as well as the *danau* itself, are marshy during the dry season. During the rainy season, however, they furnish the traveller with a very welcome water-route.

The lakes and the channels which connect them are therefore remains of the old river course, in which the *danaus* represents local deepenings of the river-bed.[1] Their extension parallel with the rivers is a sufficient proof of this.

The *danaus* possess no true banks, and their extent is subject to great variations. Such a *danau* has a peculiar aspect, as I had the opportunity of observing in the *danau* Kalahai, belonging to the R. Barito. The whole of the surrounding landscape is still and desolate. One finds oneself on an expanse of water surrounded by large primeval forests. The water itself is brownish-black but clear. Nearer the surface the colour is lighter than below. This is particularly well seen by resting an oar obliquely in the water. When poured into a glass the water is clear and light. The dark coloration is due to its taking up organic matter resulting from the decomposition of plant-remains accumulated during long years[2] The way to such channels has sometimes to be first cleared by the hatchet; but, surrounded by huge trees and climbing plants, it produces an impression never to be forgotten. The view of the lake varies according as it is a dry or a wet season, as I observed in the *danau* on the left

---

[1] S. Müller S. 22; Beoker S. 7. Personal observations.

[2] According to Gerlach (W. 45) the brown colour of the water is partly due to the presence of iron, also to the fact that the water flows through coal-measures.

The spring-water in the marshy districts is of the same nature, as is shown by an analysis of spring-water in Bandjermassin. The colour of the unfiltered water was yellowish brown, due to organic matter. The filtered water contained 64 milligrams of chlorine per litre. The black residue, on evaporation, weighed 0.316 grains, and was, with difficulty, calcined to whiteness. Traces of albumenoid ammonia were found, but none of the free gas.—(J. v/h. in N. I., 1880, II, 101).

bank of the R. Negara, near a place bearing the same name, during my journeys towards the boundary mountains in the interior. Near this place the tributary Betang-Alai runs into the R. Negara. We travelled up the former, but soon reached the place where it disappears into a lake. In the broad expanse the course of the river can only be followed where the current is strong. The river had to all appearance lost its bed. During a second journey through this district during the dry season, I was surprised to find a totally different scene. The great lake had to a great extent disappeared: in its place was a black arable land, with here and there a patch of water, the river bed of the Batang Alai being distinctly marked.

On the R. Barito the lakes extend over twenty-two geographical miles, being situated sixteen geographical miles inland, beginning from 2° 30′ to 1° south latitude. Their number is very large. The most important are: the *danaus* Kalahai, Masura, Medara, Pamingir, Babai, etc. In the course of the tributaries Negara, Karran, Siang, and Pattai, there are also some small lakes. There is also a large number of lakes in the course of the R. Kapuas. In the R. Kahajan the lake region commences fifteen geographical miles inland (above Pilang), and extends for a distance of eighteen geographical miles (2° 20 to 1° 10′ south latitude). It contains fewer lakes than the R. Barito.[1] The western rivers also have lakes, although not on such a large scale as those on the east; and on their tributaries many *danaus* are occasionally met with, for instance, on the R. Rungan.[2]

The lower river course is characterised, as already mentioned, by islands and deltas. Besides these, the so-called *antassans* are peculiar to it. The finest example of an *antassan* is the R. Menkatip, which, branching off from

[1] Schwaner S. 16, Borneo I. 21 ; II. 13.

[2] Aardrykskundige Aanteekeningen S. 30, p. 266.

the Barito at a place bearing the same name, flows in a south-westerly direction, and about half way divides into two arms, the right one, R. Mandangei, emptying into the Kapuas, whilst retaining the same direction, while the left one, which bears the former name, runs in a direction north and south, and flows into the R. Pulu Pelak. The same is the case with the R. Pamingir, and the rivers Barito and Negara.[1] In former times the R. Kapuas also had a mouth opening into the sea; while at present it is the largest tributary of the Barito. The Barito itself forms with its two arms (Barito and Pulu-Petak) a delta thirty-eight[2] geographical miles wide. Its forks (Muara Andjaman) lie seventeen geographical miles inland. This district is subject to daily inundations, and remains under water often for months during the rainy season, only isolated high-lying places remaining dry. The soil is composed of a brown clay, rich in humus and containing shells. It is separated from the sea by a tract of sea-sand, which at low water lies dry at times for a distance of 2,000 paces.[3] The lower river course is also characterised by its elevated banks, through which it runs as if between embankments, the banks sloping on both sides into the marshy land. This is well developed on the Kahajan, where the high river banks extend inland as far as Pilang, ten geographical miles inland, and then disappear.[4] The islands are formed by mud-banks deposited during high water. There are sixteen such islands in the lower course of the R. Barito.[5] A part of the mud, however, is carried far out to sea, and forms very dangerous mud-banks just beyond the river mouths. Thus at the mouth of the Barito there is a large bank which prevents ships, drawing twelve feet of water, from entering the river. Ships drawing eleven feet can only pass it at high tide; but for ships

[1] Schwaner S. 16, Borneo I. p. 23.
[2] Ib., S. 9.
[3] Ib., S. 16, Borneo I. p. 131.
[4] Ib., Borneo II.
[5] Aardrykskundige Aanteekeningen S. 30.

drawing eight and nine feet it is always navigable. Ships having a larger draught easily run aground, and must sometimes wait days for a high tide. There are places of only five to six feet depth at average low water; so that, in order to make a safe passage, the high tide must be waited for. The difference amounts to eight feet.[1] There are also banks lying before the mouths of the other rivers of South Borneo, for instance, those before the mouth of the Kahajan.[2]

Here, again, a very different picture is presented during the rainy sèason to that in the dry season. The most correçt observations on this subject have been made on the rivers Riam Kiwa and Riam Kanan.[3] The difference in the water level between the low-water and high-water line amounts to from five to seven metres. During floods (Bandjer) the water rises about 1·5 metres more, while the lowest water line is 0·3 metres.[4] The width of the rivers at low water is, compared to that of high water, as 4 : 20, and at Bandjer, as 4 : 25. The lowest water level continues from the end of August to the middle of October. The water begins to fall at the end of June. During the west monsoon navigation on the rivers near Bandjer is dangerous, on account of the many whirlpools; and at low-water, on account of the reefs and sandbanks, the river is only navigable for small boats. The rivers are always changing their beds, tearing whole portions of the land away, and forming loçal sandbanks. Thus the river-bed is continually being altered; so that charts soon become valueless.

---

[1] Menten S. 48.

[2] Aardrykskundige Aanteekeningen S. 30.

[3] P. van Dyk S. 47.

[4] In the R. Barito, near Muara Teweh, 0° 6′ south latitude, the difference of level during eight months in the year 1883-1884 was, according to the author's own observations, 14 metres. Near Sintang, on the R. Kapuas, the difference in 1877 and 1878 amounted to 15.64 metres (J. v/h. M. 1880, II. 21); according to van Lynden about 30 feet (Veth I. 25).

(2) River-Basin of the West Coast.

While in South Borneo a large number of great rivers flow through the outspreading plains to the sea, in West Borneo there is only one large river-basin—namely, that of the Kapuas Bohang. Its sources lie in the central mountains of Borneo, and the stream runs in general in a south-westerly direction through the western division, emptying into the Karimata Straits. Its sources are the Duri and the Bunga. The tributaries on the right bank down to Sintang are as follows:—the Siban, Ambalan, Labojan, Sawan, and Katungan all rising in the northern boundary mountains; on the left bank are the Mande, Bojang, Djoukong, and Silat. At Sintang its largest tributary, the Melawi or Melahui, joins it. A little above Sintang the Kapuas is 1,072 feet wide, and at the mouth of the Melawi, 1,770 feet, while the latter itself is 2,240 feet. Its source lies in the south-western mountain chain. Its springs or tributaries are the Arong, Ambalan, Lakawe, Serawai, Madalei, Ella Bohang, Ella Bosohang, Pinoh, and Blimbing. Its direction is more or less east and west; but at the mouth of the R. Pinoh it turns to the north. Below Sintang the tributaries on the right bank of the Kapuas are: the Blintang, Sikajam, and Tajan; on the left bank: the Spauk, Skadan, Amboan, and Melian. Below Tajan the great delta of the Kapuas begins, at a point about twelve geographical miles inland. The distance on the coast between the two mouths is about fifteen geographical miles. Before the mouths lie mud-banks, which only allow larger ships to enter at high tide.

Lake formations (*danau*) are also present in the course of the R. Kapuas.[1] The lake district is found north of Salimbau. It is reached by way of the R. Tawan.[2] The different lakes, Danan Blidah, Tenehang, Sintarong, Sum-bei,

---

[1] Discovered by Hartmann. See p. 17. [2] Gerlach W. 45, p. 32.

Luwar, Sumbah-Malaju, Seriang and Tongit, are connected by the rivers which flow through them. Their depth at average water-level varies from two to thirteen fathoms. They dry up during the dry season, so as to expose the river bed, as in the R. Negara, in South Borneo, already described. During the rainy season its floods extend as far as the foot of the surrounding mountains, which are 2,000 feet high, submerging the whole forest, the tops of small trees even being under water; while, on the other hand, during the dry season, it is said to have been completely dried up in 1877.[1]

Besides the Kapuas and its tributaries we have, in West Borneo, the rivers which rise in the spurs of the northern mountain chain, and those in the south flowing from the south-western mountain chain.

In the first-named district, "the Chinese Districts,"[2] the principal rivers are the following:—the great R. Sambas with the Sidin and the lesser Sambas; and the S. Sebankau with its tributaries the S. Buduk, S. Slakkau, S. Raja, S. Duri, S. Mampawa, and S. Peniti.

The R. Landak unites at Pontianak with the Kapuas, forming the northern arm of that river.

Lying at the mouth of most of the rivers there is a sandbank which occasionally can only be passed by big ships at high water. An example is the mouth of the R. Palo.[3]

The great R. Sambas is navigable to its junction with the R. Sidin; so also is the lesser Sambas as far as Sambas for ships with a draught of from 7 to 8 metres.

The river Sebankau and Slakkau are also partly navigable for small steamers, and the same is the case with the R. Landak and Njabong.

All the rivers are, of course, navigable for a much greater distance in proahs,[4] but this depends greatly upon the amount of water in them. For example, the S. Mam-

[1] Le Monnier N. 40, p. 474.

[2] Van Schelle W. 66, p. 281 and 283.

[3] Everwyn W. 39, p. 47.

[4] Canoes used in the interior.

pawa is navigable for proahs as far as Mentidong,[1] the S. Peniti as for as Pangkallan. But these rivers get gradually silted up by the mud derived from the gold washings. For instance, the R. Peniti and Mandhor (tributary of the R. Landak) is not now navigable for as great a distance as in former times.[2]

In Sukadana the principal rivers are the Simpang, Pawan, Pesaguan, and Kandawangan.[3] All these deposit mud at their mouths, and form sand-banks, like the other rivers of Borneo. For instance, the sand-bank before the mouth of the R. Pesaguan is so large, that even during high water, only small craft can enter. A similar sand-bank exists at the mouth of the R. Kandawangan.

The width of the rivers at their mouths is considerable. The R. Pesaguan, at a little distance from its mouth, is from 100 to 150 metres wide; the R. Kandawangan, the largest river in the south-west, is 600 metres wide. The latter is navigable for a distance of 425 kilometres, to a place called Pa Ruik, for small sailing vessels of 22,000 kilograms tonnage (= 360 pikol), and for craft of 2,000 kilograms tonnage for a distance of 825 kilometres.

(3) River-Basin of North Borneo.

North Borneo is traversed by numerous rivers, Sarawak alone containing eleven large streams. Of these the R. Redjang is the largest. It plays the same part here as the Barito in the south, and the Kapuas in the west. Its sources lie for the most part in the "central mountains," in which all the chief rivers of Borneo are said to spring. With its six mouths it forms a many-armed delta about sixty-four square miles in area.[4] The distance between its two chief arms—Rejan and Egan—is about fifteen geographi-

[1] Everwyn W. 33, p. 49.

[2] Ib. W. 33, in Jaarbock, p. 133.

[3] Le Roi en O Croes, W. 41.

[4] Estimated from Crocker's map.

cal miles along the coast, and the delta begins at a distance of thirteen geographical miles inland.[1] The width of the river at the beginning of the delta is one and a-half English miles; near Kanowit, fifteen geographical miles inland (as the crow flies), it is half an English mile wide. The depth amounts to about four fathoms at a distance of 100 English miles inland. The R. Redjang is navigable to Balleh, about thirty geographical miles inland, where the first cataracts begin.

The next largest river in Sarawak is the Batang-Lupar, which takes its source in the boundary mountains of the same name. Its lower course resembles a narrow arm of the sea, with a width of from two to three English miles on the coast. The mouth itself is marked by two conical hills on the right bank, while the Trisanh island lies in the middle of the river.[2] Up to its Junction with the R. Lingga, a tributary on the left bank, twenty miles inland, the Batang-Lupar is navigable even for ships of 1,000 tons. At this place there is an extraordinary swelling of the river during the spring tides. This phenomenon commences three days before full moon, terminating three days after. One single tidal wave, about six feet high, rolls up the river for about sixty English miles, overflowing everything that it meets. This, and the numerous sand-banks, make the navigation by way of the Lingga dangerous.[3] Inland, the river becomes very narrow: at about eighty English miles inland, near the mouth of the R. Sakaran, it is only 100 yards wide.[4] At its mouth it has a depth of 10 feet (=3 fathoms) at the time of low water.[5]

The river Sarawak is also worthy of mention: it rises along with the Sambas in the boundary mountains, and is formed by the union of two chief arms. It also forms a large delta,

[1] Crocker N. 34.
[2] Spenser St. John N. 9.
[3] Crocker N. 34, p. 196.
[4] Spenser St. John, N. 9.
[5] Crocker, N. 34.

about six square geographical miles in area,[1] with the two chief arms, Santubong and Morabatus,[2] the mouths of which are marked by isolated peaks. On the east the R. Samarahan communicates[3] with this delta: it is to be regarded as a tributary on the right bank of the R. Sarawak, extending as far as the mouth of the R. Lundu in the west.[4] The R. Samarahan is impassable on account of the bar at its mouth. At the mouth of the R. Sadong, the water is seven feet deep at low tide, and in the R. Lundu, three feet.

The remaining rivers of Sarawak: the Saribas, Oyah, Mukah, Balinean, Tatau, and Bintulu, are of less importance. The R. Saribas has a wide and deep entrance, and is fairly deep thirty-five English miles inland. The Oyah and Mukah rise in the Ular-Bolo mountain chain. The R. Tatau receives its name from the mountain (1,890 feet high) bear- the same name, situated about ten English miles from its mouth. All these rivers have bars at their mouths.[5]

In the Brunei State the two chief rivers are the Barram and the Limbang.[6] St. John was the first to navigate them both. The first named rises in a central mountain chain, and runs northward towards the coast, emptying into the sea near Cape Barram. At its mouth it is half an English mile wide, and forty-five English miles inland, it is at least three fathoms deep. On the bar before its mouth, there is six feet of water at low tide; but immediately behind it there are from four to five fathoms. Its largest tributary is the Sinjah. The R. Limbang has its source in the northern mountain chain, and empties into the Bay of Brunei. Its

1 Estimated from Crocker's map.

2 At high water even the largest ships can enter.—Le Monnier N 46, p. 455.

3 Spenser St. John N. 9.

4 Crocker N. 34.

5 Le Monnier N. 40, p. 475.

6 Spenser St. John N. 9. Since the last few years the rivers Barram and Trussan have belonged to Sarawak.

largest tributary is the Madalam. Little is known about the R. Trusan, which also rises in the boundary mountains, nor of small R. Tutong.

In Sabah the largest river is the Padas, on the north-west coast, with its extensive delta forming the northern boundary of the Bay of Brunei.[1] The remaining rivers are unimportant, as for instance—the Kimanis, Papar, Tawaran, Tampasuk, and Sekuati.

The rivers of North Borneo have the same character as those in South Borneo. Lakes are also formed to a certain extent, as is shown on the R. Simunjan, where there is a lake surrounded by hills.[2] This lake has, together with the surrounding marshes, an area of about two square geographical miles, and lies some miles to the north of the gently undulating Klinkong and Sibok mountain chains. The streams originating in these mountains empty into the lake, the outlet of which is formed by the R. Simunjan.[3] Lakes are by no means so numerous as in South-east and West Borneo.

It has already been mentioned that delta formations also occur in the larger rivers, although the lower course of the rivers is less developed, and in the smaller rivers it is marshy. Thus, for instance, the marshy plains of the lesser R. Sekuati extend for more than two English miles inland.[4]

(4) River-Basin of East Borneo.

On the east coast of Sabah, which is the most north-easterly point of the island, the largest rivers are the Sugut, Labuk, Kinabatangan, and Segamah. It is still unknown where they rise. The largest among them is the Kinabatangan, and has been furthest navigated by Frank Hatton and Daly.

---

[1] Navigated by De Crespigny and Leys.

[2] Spenser St. John N. 9.

[3] Xanthus N. 30, *a*.

[4] Frank Hatton N. 48.

In the lower course these rivers present the same character: which consists in the formation of deltas. Thus the R. Labuk empties through three mouths into the Bay of Labuk, and the R. Kinabatangan has a delta of considerable extent. The river mouths are shallow, and have sand-banks.[1] For instance, the R. Labuk, which is one English mile wide, has a sand-bank with a channel.[2] Again there is a bar in the mouth of the R. Sibuko, which empties itself into the Bay of Sandakan. Through the latter there is a channel about twenty metres wide, which has a depth of only 1·5 metres at high water.[3]

Little more is known than the names of the rivers of the Sidung States, and the countries Berau and Bulongan. Their sources are to be sought far away in the interior of the island. We find here the Sibuko, the river forming the nominal boundary between Sabah and Dutch Borneo, further the Sibawang, Bulongan or Kajan, and Berau, with its two large tributaries the Segah and Kelah.

At the mouths of all these rivers deltas occur, intersected by numerous channels, *antassans,* sandbanks, and islands. Thus the coast of Sidung is represented on old maps as very broken, like that of Norway; this is chiefly caused by the numerous *antassans.*

In later years the R. Berau has become better known.[4] At its mouth there is a large delta with the following mouths counting from north to south: Kwala Tidung, Manussur, Garura, Pantei. The last-named is the one most used for navigation. The distance between the two mouths amounts to about 28 kilometres, and the distance from the Pantei mouth to the Gunong Santul, the termination of the delta, is 42 kilometres. The marshy Berau delta has an area of about 580 square kilometres = 10 square geographical miles. Fifty-five kilometres inland the river branches into

---

[1] St. John N. 9.
[2] Frank Hatton N. 48.
[3] Dr. Montano N. 31, p. 185.
[4] H. von Dewall E. 6, p. 126.

its two chief arms, the Segah and Kaleh.[1] Where they unite they are from 300 to 400 metres and from 200 to 300 metres wide respectively. After the union the river is from 600 to 1,200 metres wide, and of an average depth of 5·50 metres at ordinary water-level.

The Segah is navigable for trading proahs of two feet draught, for five days' journey (in a native proah): further up stream, only for small boats.[2]

We have more accurate information with regard to the rivers in Kutei. The large R. Mahakkam occurs here. The source of this river is to be found in the "central mountains;" and it runs more or less in a south-eastern direction towards the Straits of Makassar. The tributaries on the right bank, among which are the Njerobungan and Pahu, rise in the south-eastern boundary mountains. The tributaries on the left bank take their sources in the eastern mountain chain. Among them are the great R. Telen, coming from the Kutei Berau boundary mountains in the lower course called the Kanan, further the Klintjau and the Belasan. The basin of the river Mahakkam has the same character as that of other rivers.[3]

The width of the river at Tengaron is 900 metres, with a depth of from 8 to 9 metres; at Samarinda, 600 metres; at the beginning of the delta, 900 to 1,000 metres, with a depth of 9 metres at high water.[4]

Near Sanga-sanga, the river divides into three arms, Muara Berau, Budji, and Djawa, which again sub-divide forming an immense delta. Its extent along the coast is about ten geo-

---

[1] Hooze E. 13, p. 17-20.

[2] Hooze E. 14.

[3] We have to thank H. von Dewall for the greater part of our information about this river. A chart was also prepared by him. In addition, we possess a section of Schwaner's of the R. Mahakkam from Muara Pahu to Kampong, Longmerah, and from the mouth the R. Pahu to the R. Teweh, a tributary of the R. Barito.

[4] Hooze E. 14.

graphical miles, and to the fork, three geographical miles. The many islands forming the delta are known under the name of the Pamarong Dendrekin Islands. Sandbanks stretch across the mouths, making the entrance difficult for ships.

The middle course is marked by the occurrence of several lakes, which extend for about thirteen geographical miles along the river, from Muara Pan to Muara Kaman.

The lake district is, according to Dewall, an immense expanse, more extensive than those of the Barito or Kapuas. The most notable lakes are: Djembang, four geographical miles long, one geographical mile wide; Kaju Bunga, and Priean Uwis, one geographical mile long, and a half geographical mile wide. Rivers flow into them, and they are connected by channels with the Mahakkam. During the rainy season they increase, but in the dry season some of them partly dry up.[1]

The rivers in the southern states of East Borneo are less in size, the shortness of their courses being determined by the close proximity of their sources.

In Passir, there is the R. Kendilo or Passir; in Tanah Bumbu, the Tjengal, Menungul, Sampanahan and Bangkalaan; in Kusan, the Batulitjin and Pagattan, or Kusan.

The sources of the rivers are in the near-lying south-eastern boundary mountains. Their direction is a west and easterly one, with the exception of the Kendilo, which flows at first parallel with the mountains north and south, but later on turning towards the east, empties into the Straits of Makassar. The lower course is of less extent, and on that account the rivers are only navigable at high water.

The *antassans* are also present here, connecting up the rivers; they also empty independently into the sea. Lakes (*danau*) also occur, for instance, in Kusan. The lake Betambun lies two German miles distant from the coast; through

---

[1] Hooze E. 14.; Weddik E. 5.

its dark water flows a river, and its water is salt during the rainy season.[1]

Bays and Harbours.

No good harbours are to be found in the whole of Borneo, with the exception of Sabah, the most north-easterly point of the island. But here they occur in great abundance, and of good quality. Excellent harbours are furnished by the bays of Ambong, Abai, Gaya, Marudu, Labu, and Sandakan, all in the possession of the North Borneo Company.

The Bay of Brunei is also one of the finest on the whole coast. It is surrounded by mountains reaching a height of 8,000 feet, and in the innermost bay a "hill-land" is visible.[2] The only harbour offering any shelter on the north coast, from Cape Sirik as far as Labuan, is the Bay of Kidurong; but this has only a depth of two and a-half to three fathoms.[3]

(II.) THE GEOLOGY OF THE "MOUNTAIN-LAND."

(Crystalline Schists, Older Eruptive Rocks, and Old Slate Formation.)

The mountain chains and their spurs are composed of crystalline schists, the "old slate formation" of Devonian (?) age, and older eruptive rocks.

It appears desirable to treat these rocks in one section, although they are of different ages, as they have not yet been properly separated. This is especially so with regard to some of the members of the first two groups, so that in certain cases it is not clear where certain groups of slates are to be placed. Further, because all these rocks together constitute the "mountain-land" or "mountain formation."

---

[1] Weddik E. 3, and Schwaner E. 5. [2] Le Monnier N. 40, p. 483.
[3] Le Monnier N. 40, p. 477.

Only a few parts of the "mountain-land" have been closely examined geologically. Many parts are still entirely unknown, and of the greater part of the remainder we only possess general petrographical data.

South Borneo.[1]

Exact geological details are only known of the south-eastern part of the island: the districts Tanah Laut, Martapura (with the exception of the Rantau District), and Bandjermassin. The remaining "mountain-land" is only known superficially, *i.e.*, we possess a few data which compared with other better known districts, give some idea of its geological structure.

Tanah-Laut and the Southern Part of Martapura.

A great part of the Meratus mountains consists of crystalline schists. Thus the Gunong Gergadji consists of mica- and chlorite-schist, and similarly its south-western continuation, the Dilam mountains, is composed of the same rocks. The rocks underlying many of the alluvial gold deposits is also, in many cases, a much weathered mica-schist.[2] Further crystalline schists appear to occur near the sources of the river Kalaan (tributary of the riam Kanan), in the Meratus mountains—a conclusion warranted by the river pebbles[2] Further, the G. Mango Sangor, to the N.E. of the Pamatang hill range, is marked as schists on C. de Groot's Geological map.

---

[1] For our information respecting the south point of the island we have to thank Horner (S. 2), Müller (S. 22), Schwaner (S. 17), C. de Groot (S. 23), but more especially Verbeek (S. 41), and Hooze. With regard to the remaining districts we are dependent almost exclusively on Schwaner (S. 17), and Von Gaffron (S. 27), p. 105.

[2] Java-courant, 1884, III.; 1885 I. (verslagen v/h Mynwezen).

Again, these schists are abundantly developed in the Bobaris mountains, where, up to the present, they are only known at one large place, south of the mountains.[1]

For the most part they are mica-schists, alternating with hornblende and quartzite-schists, the latter sometimes passing into mica-schist. The mica-schists contain a silvery-white or light green mica, and the amount present is considerable, so that the rocks are highly fissile. A greyish-white quartzite rock, containing pyrites, forms the top of the mountains Tamban and and Lamut, the remainder of which consists of eruptive rocks. Among the quartzite-schists is one variety consisting chiefly of quartz-grains and a brown mica. It is fissile and easily crumbled. This schist reminds one of itacolumite. The hornblende-schists are dark green, and consist of quartz and green hornblende. They form the waterfall on the Riam Kanan. It is noteworthy that the crystalline rocks are much traversed by quartz-veins of a metre thickness, which are sometimes gold-bearing.

The strike of the crystalline schists on the southern border of the Bobaris mountains, is a north-east and south-westerly; the dip is 50–60° towards the N.W. from the mountains; on the other hand, a small patch of mica-schist occurring in the middle of the Tertiaries on the river Kalaan is horizontally bedded. They form the mountains Pamatang-Ambawang, Bekattir, and Menjander, which are approximately 300 to 400 feet high.

Rocks belonging to the "old slate-formation" appear, according to the latest researches, also to occur here.

A sedimentary formation is stated by Hooze (Javaverslag, 1887, I. and II.) to occur between Pengaron and the Bobaris mountains. It consists of quartz-schists and clay-phyllites. These are doubtless a part of the "old slate formation." On

---

[1] Verbeek S. 41.

this point there is no later information. The same district was described by Verbeek as late Tertiary.

Among the "older eruptive rocks" constituting the "*Grundgebirge*" are granites, diorites, gabbros, and serpentines. The two latter appear to belong rather to the secondary chains.

The last spurs of the Meratus mountains, close to the coast of western Tanah-Laut, form the hill-ranges Tima, and the neighbouring island Datu (fifty metres and twenty to twenty-five metres high, respectively), striking S.W. by W. and N. by E. Coarse-grained, sometimes schistose, gabbros, with greenish serpentine, occur here. Both are traversed by veins of felspar, one of which contains copper and magnetic pyrites.[1] Similarly there is a hill consisting of gabbro, near Tessikong north of B. Tima.[2] On the same strike further inland the "serpentine formation" again occurs, constituting several hills. For instance at Bukit-besar, where a serpentine[3] traversed by quartz-veins occurs; at Bukit Pantej, where aphanite and aphanite-porphyry[4] occurs; at G. Pamatong where gabbro[5] crops out, and also in the brook Danau-Krassik. Diorite constitutes the mountain Pamalutan.[6] Dykes of serpentine occur on both sides of the Dilam mountains, and the same rocks underlie the auriferous alluvium in several places.[7] Diorite also form the mountain Sakumbang[8] and the mountains Tamban and Lumut (north of the Bobaris mountains). The rocks of the latter are fine-grained, compact, grey quartz-diorites.[9] The whole of the Bobaris mountains

[1] C. de Groot S. 23, p. 57 in Jaarboek.
[2] Java-Verslag, 1880, IV.
[3] Schon C. de Groot.
[4] Only microscopic determinations of the rocks were made.
[5] L. Horner S. 2, and S. Müller S. 22.
[6] C. de Groot S. 23, p. 57 in Jaarboek.
[7] Java Verslag, 1883; III. and 1885 1.
[8] L. Horner S. 2, and S. Müller S. 22.
[9] Verbeek S. 41, p. 46, 47.

consists of gabbro and serpentine. Verbeek found the coarse medium-grained gabbro *in situ* in only two places; the serpentine is compact, dark-green and occasionally magnetic.

The granites and syenites,[1] already noted by Horner, are not mentioned separately; but Verbeek found, in a small tributary of the river Bantan, north of the G. Lumut, a much weathered syenitic granite *in situ*, consisting of red and white felspar, quartz, brownish-black mica and a little hornblende.[2]

South-eastern Mountain-Chain.

We know nothing of the geological structure of the Pramassan-Amandit mountains, except that quartz-veins, containing pyrites, occur there. These are either in the old slates or in eruptive rocks.[3]

Of the northern extension of the mountain chain (the Pramassan Alai mountains), we only know that they also consist of crystalline schists and older eruptive masses. River-pebbles found by Posewitz in the neighbourhood of the mountains near Pagat consisted of hornblende schists, diorites and granites. During his stay in this neighbourhood pyrites crystals, obtained from these mountains, were also shown him. These indicate quartz-veins occurring in the slates.

Farther to the north the boundary mountains assume a more hilly character (on the border of Kutei), extending to the neighbourhood of the central mountain core. "Here we only find isolated elevated ridges and peaks which probably belong to the 'mountain formation.'"[4] That the mountain formation has, however, only an isolated occurrence here

---

[1] L. Horner S. 2, and S. Müller S. 22.

[2] Verbeek S. 41, p. 46 and 47.

[3] A report of the natives to the effect that gold occurred in a gully of this mountain, led to its examination, with the result that only pyrites was found (Jaarboek, v/h Mynwezen in N. J., 1873, I. p. 237.

[4] Schwaner S. 16, I. p. 25.

is shown by the absence of alluvial gold in these districts (basins of the Ajo, Teweh, Lahay), which does not occur because of the absence of the mother-rock.

The strike of the "mountain-land" is, in the middle portion of the boundary chain, parallel to the watershed; further to the north, for instance (*e.g.*, the Saing-Bong mountain), it has a W.S.W. and E.N.E. direction.[1]

Central Mountains.

The nature of the central "mountain-core" can only be deduced from the pebbles that are found in the rivers. The district surrounding the sources of the Barito appears to consist chiefly of granitic rocks, especially a coarse-grained granite with white mica. The mountain chain (3,000 to 4,000 feet) striking S.W. and N.E above the river Topo, consists of granite and similar rocks. Besides granite, however, rocks of a "dioritic nature" are also found, constituting chiefly the mountain ridges Batu Bundang. These rocks are traversed by quartz-veins, containing pyrites, as is shown by the pebbles out of the river Boboat.[2] The strike of this range is in general N.N.E. and S.S.W.[3]

South-western Mountain-chain.

This has the same structure as the others; there is only this difference in the eruptive rocks, namely, that in the north-eastern parts "diorites" predominate, while in the south-western mountain chain "granitic rocks" are more to the fore.

The mountain land to the east of Bukit radjah (which belongs to the upper basin of the river Kahajan) consists of coarse schistose, gneiss, mica- and hornblende-schists, and hornstone with which eruptive rocks (*e.g.* diorite and ser-

[1] Ib. S. 16, I. p. 4 and 5. [2] Ib. S. 16, I. p. 23; S. Müller S. 22.
[3] Ib. S. 16, I. p. 4 and 5.

pentine)[1] are associated. These rocks are traversed by pyrites-bearing quartz veins, sometimes of such considerable thickness that one might suppose that the rock was wholly made up of quartz.

These determinations are made on boulders, varying in size from a fist to a man's hand, found in the upper Kahajan and Miri rivers, and on rocks formed *in situ* above Bereng Kasintu on the river Kahajan.[2] The strike of the parallel mountain-chains is north-east and south-west.[3] West of Bukit radjah near Mount Senamong, in the upper basin of the river Katingan, granitic instead of dioritic rocks are found.

A coarse-grained, quartzose granite with pink felspar and dark green mica is frequently found in pebbles, and builds the greater number of the rapids. But syenite, gneiss, and dark-green hornstone also occur.[4]

The northern escarpment of this mountain-land consists of similar rocks, as, for instance, mica-schists, associated with vein-quartz, hard dark-green crystalline horn-stones, granite, porphyries, and syenites; and they are also found as boulders in the river bed of the Serawai (West Borneo).[5]

The strike of the mountain chains is W.N.W., E.S.E., and of the G. Asing, E. by N., W. by S.[6]

The subsidiary chains in the western parts of South Borneo form an extended "mountain-land."[7] In the basins of the Kotaringin and Pembuang, the higher mountains consist of gneiss and greenstone. The former also occurs near the sources of the river Kwajan, a tributary of the river Sampit, but it is, in general, of infrequent occurrence. Greenstone occurs almost exclusively in the northern parts of the river Sampit, in the basins of the Sampit and the Pembuang;

---

[1] Granite is not mentioned.
[2] Schwaner S. 16, I. p. 56 and 64.
[3] Ib. S. 16, II. p. 59.
[4] Schwaner S. 16, II. p. 134 and 141.
[5] Ib. S. 16, II. p. 159 to 162, 177.
[6] Ib. S. 16, II. p. 136 and 138.
[7] Ib. S. 22 (Von Gaffron).

and Mount Kaki, in the district of Katingan, consists entirely of this rock.

The rocks here are traversed by pyrites-bearing quartz veins; for example, in the neighbourhood of Mount Mentaweh, and in the basin of the river Sambi. (In this river iron-pyrites is found in the neighbourhood of auriferous districts, being probably derived from veins.) Again, the wide distribution of alluvial gold in these basins indicates indirectly a wide distribution of the mother-rock.

Of the mountain-spurs in South Borneo there still remains the Gunong Pararawen, which, striking mainly W.S.W. and E.N.E., runs generally in a southerly direction. Von Gaffron mentions "plutonic rocks" at this place in his geological map[1]; and Posewitz,[2] who ascended this mountain in 1883, in order to investigate its geological structure, describes a medium and a coarse-grained very weathered rock from the top. Thin sections could only be prepared of the first-named: these showed the rock to consist of a crystalline granular aggregate of quartz, felspar, mica, and magnetite. Posewitz places this rock provisionally with the granites, as it was too decomposed to allow of specific determination.

A schistose rock was also found.

Dykes in the "Mountain-formation."

Dykes of *eruptive rocks* are up to the present unknown in South Borneo. Among *mineral veins* mention is often made of quartz-veins of varying dimensions which occur in great abundance in the slates.

Ores in the "Mountain-formation."

Gold occurs in the quartz-veins, also in scattered granites, etc. (impregnation).

Magnetic iron-ore occurs in grains scattered through the serpentine; perhaps, also, in the diorite.

---

[1] J. v/h M. 1882, II. [2] Posewitz S. 51.

Age of the Eruptive Rocks.[1]

With regard to the age of the granitic rocks we have no positive facts in South Borneo. In general they are little known. Probably they are among the oldest eruptive rocks, older than the diorites, gabbros, and serpentines. Verbeek reports on the age of the latter rocks.[2]

The diorite of Mount Tamban appears to be older than the Eocene, as beds of this age are undisturbed in the immediate neighbourhood of the mountain, and the coal-bearing sandstones, dip gently towards the diorite. The gabbro appears, according to Verbeek, to be partly of Eocene, partly of Miocene age. "In some places its intrusion seems to have taken place in the beginning of Eocene times; in others, during the Eocene period, and in others again, during the Miocene period."[2]

At one place, on the river Riam Kanan, a breccia of coarse fragments of quartz and slate, cemented by a serpentinous material, lies between the highly-inclined crystalline schists and the serpentine of the Batara Bulu. The serpentine thus appears to have broken through the slates, and is, consequently, younger than they. On the other hand, the Tertiary strata are horizontal in the neighbourhood of the serpentine, and neither dykes nor fragments of gabbro or serpentine are to be found in them.

---

[1] In the western well-known parts of Sumatra, the "old eruptive rocks" are separated into a *granitic group* (granitite, quartz-porphyry, hornblende-granite, syenitic granite, quartz-diorite), which are not all of the same age, as some of the quartz-diorites traverse the granites, and a *diabase group* (diabase, gabbro, serpentine) determined to be younger than the Carboniferous Limestone, but how young, is uncertain, as all subsequent formations up to the Tertiary are absent." (See top. en geol. beschryving van een gedeelte van Sumatra's Westkust door R. D. M. Verbeek, 1883, p. 31.)

[2] Verbeek S. 41, p. 34–40.

[3] Verbeek S. 41, p. 39.

West Borneo.[1]

Our information with regard to the "mountain-formation" of West Borneo is very variable. Least known are the river basins of the Upper Kapuas and Melawi. Our information is more exact with regard to the southern portion—Sukadana—constituting the spurs of the south-western mountain-chain; but we know most of the "Chinese Districts," where, between 1880 and 1890, extended investigations were made.

Although the "mountain-formation" in Sukadana and the "Chinese Districts" is separated from the coast by a broad strip of alluvium, yet its spurs extend to some isolated hills on the coast, and even the neighbouring islands have the same geological structure.

In the "mountain-formation" of this area the crystalline schists play, as before, a subsidiary rôle; even being, apparently, quite absent in the "Chinese Districts." On the other hand, we find the "old slate-formation" developed in great thickness here, and also in Sukadana (although of small lateral extent). It is traversed by numerous quartz-veins, containing gold and other ores. It is an interesting fact that other rocks beside clay-phyllite and quartzite form a part of its structure, imparting a more varied development.[2]

Both formations are traversed by granitic rocks, diorites, gabbros, etc., the nature and relative age of which have been determined. Altogether the "Chinese Districts" is the best known part of West Borneo.

The Chinese Districts.

The oldest sedimentary rocks here are those of the "old

---

[1] Our information is chiefly derived from Everwyn and Van Schelle; but also from Schwaner and Von Gaffron.

[2] It is, however, quite possible, that a portion belongs to another formation (Tertiary), especially in Sukadana, as the investigations have, up to the present, been only of a general nature.

slate-formation," consisting of clay-slates and quartz-schists, alternating with sandstones and conglomerates.[1]

The clay-slate is often weathered, and then of a greyish-yellow colour; otherwise it is of a blue-grey colour, with a silky lustre. It is fissile and occasionally sandy. Alternating with it are thin beds of bluish-grey and white quartz-schists, which are also present in the neighbourhood of the eruptive masses.[2] The quartz-schists are often beautifully banded. They are both fine and coarse-grained, and sometimes contain disseminated iron-pyrites. These rocks, together with the associated eruptive rocks, are spread over the whole area of the "Chinese Districts," as far as cape Datu, where, as in the district of the river Palo, ranges of low hills occur, which are composed of variegated clay-slate, passing into hornstone;[3] while the Tertiary beds only occur on the eastern border. The sandstones, slates, and conglomerates, are exposed on the western border of this district, from Mandor to Montrado, and from Sinkawang to cape Blimbing. They always form steep escarpments, elevated above the surrounding flat hill-land.

Mount Hang-Ui-San (350 meters high), east of Montrado,[4] rises steeply above the surrounding "hill-land," where granite and variegated slates occur. At this place the following rocks lie conformably above one another.

(1) Fine-grained grey quartz-sandstones, somewhat argillaceous, with silvery-white scales of mica, iron-pyrites, and magnetite, sometimes in beds 1·2 metres thick and then alter-

---

[1] Fossils were found, in the eighties, in the old slates in two places in the Skadau mountains, which indicated a Devonian age.

[2] According to Van Schelle the quartz-schist was produced by silicification (during the eruption of the diabase) of the clay-slate (Jb. v/h. M. 1884, II. p. 224). That this is not always the case, I think I have been able to show elsewhere. (See Contact-metamorphism.)

[3] Everwyn W. 39, p. 80, 81.

[4] The ridge mentioned by Everwyn N.E. of Montrado, is a range of hills 300 metres high, consisting of variegated slates which alternate with an argillaceous sandstone (See Jb. v/h. M. 1879, I. p. 85.)

nating with clay slates. The bedding of the sandstone cannot always be clearly seen.

(2) A variegated clay-slate passing into a red clay, which hardens when exposed to the air (= laterite).

(3) Conglomerate of the same composition as the sandstone, with quartz pebbles which mostly contain iron-pyrites.

The bedding is in part disturbed. The strike is north and south; the dip towards the W. or S.W.

The mountain Snamang,[1] near Mandor, has a similar structure. It is elevated 800 metres above a hilly country consisting of clay slates, which in a decomposed condition also form the foot of the mountain ridge. The beds consist alternately of fine-grained clayey quartz-sandstones, clay-slates and beds of conglomerate, without attaining to any considerable thickness. The quartz-sandstone contains scattered grains of iron-pyrites and is traversed by a network of pyrites-bearing quartz-veins. The strata are highly inclined. The Tampi mountains and the hill range Djerat-Semata consist of the same rocks.[2]

The youngest and most developed formation is a hard, fine-grained, white quartz-sandstone, sometimes alternating with a conglomerate-like sandstone and in many places traversed by quartz-veins. This is underlaid by a more or less sandy, weathered slate-formation (Kleisteen vorming), white or coloured, in places easily cleaved. The steep hill Tiang, between Mandor and Montrado, consists in great part of metamorphic quartz rocks.[3]

Between Budok and Sinkawang there is chiefly a bright coloured slate formation, sometimes alternating with clayey quartz-sandstones.[4] An isolated hill near cape Blimbing[5] also consists of quartz-sandstone, as well as a range of hills south of the river Palu and near the brook Liku.

---

[1] Everwyn, W. 39, p. 49. [2] Ib., W. 39, p. 47. [3] Ib., W. 39, p. 51.
[4] Ib., W. 39, p. 83. [5] Ib., W. 39, p. 79 and 81.

It is a greenish-grey, white or reddish sandstone, sometimes fine, sometimes coarse-grained, sometimes very argillaceous. At the last-named locality it contains inclusions of clay-iron stone (passing into laterite).

Whether these beds of quartz-sandstone, slate, and conglomerate really belong to the "old slate-formation" has not been accurately determined. It is only known that they always overlie the schists. Fossils have not yet been found in them. In any case it is strange that gold-bearing quartz-veins occur there. Everwyn himself is not clear with regard to this point, for in one place he states that these rocks (slate and sandstone) belong to a much older geological period; and at another that clay-sandstones, quartz-sandstones, and conglomerates are less developed and of younger origin than the slate formation, for example at the mountains Tampi, Suaman. But, the description of these rocks by Van Schelle apparently agrees with the rocks in the Upper Sikajam district,[1] which belongs to Verbeek's Stage I. Eocene; so that probably they should also be referred, in part at least, to the Eocene. In favour of a more recent age is also the circumstance that in the Tampi mountains these rocks are underlaid by a weathered (!) slate formation.

Among the eruptive rocks there is a granitic and a dioritic group, consisting of granite, granite-syenite, granite-porphyry, diorite, quartz-diorite, and quartz-augite diorite. These rocks, but chiefly the granite and syenite, form the chief mountains. The granite in the Pandan mountains is coarse-grained, with red felspar, brownish-black mica, and quartz. Accessory constituents are hornblende, tourmaline, and iron-pyrites.[2] Almost all contain, in addition, plagioclase and hornblende. The different varieties of diorite appear to be related to the granite. Further, gabbro occurs in the Upper Sikajam district, and forms hills 1,300 metres high. It is a bluish-

[1] Jahrb. v/h. M. 1884, I. p. 126. [2] Ib. 1883, I. p. 76.

rey crystalline rock, with horizontal jointing, and consists of felspar, quartz diallage, hornblende, and mica, together with iron-pyrites and magnetic iron-ore.[1] The fine-grained varieties resemble syenite. Aplite (composed of quartz, felspar, hornblende, and a small quantity of pyrites) has been also found in loose blocks. The exact locality is not known.

Dykes[2] of diabase and melaphyre, as well as granite-porphyry occur. These were not found *in situ*, but in loose blocks.[2] Schelle found bluish-grey and fine-grained melaphyre (?) in two places in a clay-slate formation in the Upper Lambas district (near Pangkalan Batu and G. Djaboi). A melaphyre dyke crops up in the alluvium, near Pulan, on the River Djambu,—a hard compact, partly porous rock with crystals of felspar and olivine; under the microscope, glass base with plagioclase, augite, and iron-ore, and scattered porphyritic crystals of plagioclase, augite, and olivine. The islands on the coast and the isolated hills also consist of old slates together with eruptive rocks.[3]

The "mountain formation" may be regarded as a hilly land, from which isolated steep ridges or peaks rise up. The hilly land (up to 90 metres) consists of clay-slates; the high mountains (300–600 metres high) consist of quartzite; then there are the various eruptive rocks, *e.g.*, gabbro, rising to a height of 1,322 metres.[4]

The stratigraphical relations of the "old slate-formations" are much disturbed. In the Upper Sikajam district the beds have a general strike of N.E. and S.W., with a dip of 29°–50° to the S.E.; but the beds are often faulted, and turned up on edge. In the Uduber range the strike is N.E. and S.W.; the dip 65° to the N.W. In the Pandan mountains W. and E. In the Skadau mountains the general strike is N.W. and S.E., with deviations varying from E.N.E., and W.S.W. to S.E. by

[1] Jahrb. 1884, I. p. 125. [2] Ib. 1884, II. p. 287. [3] Ib. 1879, I. 48.
[4] Above the level of the R. Sikajam) see Jahrb. v/h., M. 1884, I. p. 125.)

S., and N.W. by N. In some of the hills near the coast the strata are highly inclined.

Dykes and Veins.

Eruptive Rocks.[1]—Diorite dykes occur in the granite of the islands Temadju and Penibungangan. Dykes of diabase and melaphyre traverse the granite and slates in many places in the Skadau mountains; and dykes of granite-porphyry vein the granite.

Mineral Veins.[2]—Near cape Blimbing, and on the river Palo the slates are traversed by quartz-veins with pyrites. Quartz-veins occur in the islands Temadju and Penibungan. The granite of the Pandan mountains is traversed by small veins of quartz and calcite.

Geology of the "mountain-land" in Sukadana.[3]

The mountain-formation is extensively developed at a distance of five to six miles from the coast, from which it is separated by other formations, in part alluvium.

In the southern states, Matan and Kandawangan, it forms the spurs of the south-western mountain chain. The inland country of Kandawangan and Matan is geologically similar to the Chinese districts,[4] except that crystalline schists also occur in some abundance, which is not the case in the latter districts. It is a hill-land, above which are elevated isolated mountains and mountain ridges, which do not reach any great height. Isolated spurs of these mountains are also present on the coast, and are continued into the neighbouring islands.

---

[1] Jahrb. v/h. M. 1879, I. 51; 1854, II. 287; 1879, I. 80, 81, 51; 1883, I. 6.

[2] Ib. 1879, I. p. 58–77; 1880, II. p. 1–13.

[3] Our information is chiefly derived from Everwyn; a little only from V. Gaffron and V. Schelle.

[4] Jahrb. 1879, I. p. 101.

The "mountain formation" consists here of crystalline chists, of rocks belonging to the "old slate-formation," and of ld eruptive masses, mainly granitic rocks. In consequence of he intrusion of the latter, the slates are, in places, metamorhosed and disturbed (see *Metamorphism*).

In Sukadana and Simpang the "old slates" are only known in two places, and are of sparse development.

"Metamorphic clay-slates" crop out on the small island Seranama, opposite Sukadana and near the brook Melia. Small ranges of hills to the N.E. of Sukadana and three exposures on the coast, are of syenitic rocks, while further N.E. the mountain Palong consists of granite. Again, twelve kilometres towards the interior from Simpang, a "porphyry" is exposed.[1]

In Matan, in the basin of the Pawan, mica and hornblende-schists, as well as phyllites, are exposed. They are sometimes metamorphosed. Thus, near Mount Sablangang they form a hard, dark, grey slate, and, in places, a white and grey, spotted hornstone, with disseminated iron pyrites.[2] The slates near Mount Bajor and the hill Merasai are also metamorphosed.

All the higher mountains consist chiefly of eruptive rocks, surrounded by slates. Thus, Mount Sablangang consists of hornblende-granite; syenite is found near the hills opposite Telok Aba; granite near the hill Trentang, and similarly opposite Djawi and at Mount Komam. Red felspar-porphyry and white quartz-porphyry occurs between Penulakan and Riam-Dadap.

In the basin of the river Pesaguan talc-mica schists, mica schists and phyllites occur. Mount Melaju, consisting of four hills, is made up of a granite which is sometimes fine-grained, very hard and quartzose, sometimes felspathic and coarse-grained; while syenite occurs near the brook Klampeh.

---

[1] The rock-determinations were made in the field. . .

[2] Here they are also highly inclined.

In the basin of the river Kandawangan we find the same structure. Talc mica-schists, talc-schists and phyllites (mostly of a grey colour) constitute the "hill-land" (15–20 metres). The eruptive rocks are mostly different varieties of granite (at Batukling, fine-grained; at Belaban, quartzose; at Mount Bunai, N.E. of Karangan, schorlaceous). A quartzose and micaceous granite occurs on the coast S. of the river Kandawangan, in low ranges of hills, also near Mount Mangkol. It has turned up on end the variegated phyllites that surround it. The latter form the greater part of the neighbouring island Bawal.

Most of the islands belonging to the Karimata group consist of granitic rocks: granite and syenite on Karimata, granite on Surutu, syenite on Maledang, Laja, Mentigi, Panumbangan; with which are associated old and partly metamorphosed slates.

Besides the granitic rocks, diorites have been found at two places near Maram (Kandawangan), river Ketate and Labu.

The sandstone-formation mentioned in describing the Chinese Districts is also found in Sukadana, mostly on the coast and neighbouring islands, where it alternates with conglomerates and slates.[1] With regard to its age no details are given.

The rocks which crop out on the borders of the mountain land are mostly the same as in the north of West Borneo.

The places known are the following:—the island Bessi, which derives its name from the shales and clay-ironstone developed there; the latter was worked in former times by the natives. Further, on some islands to the south-east, where the dip is 40°, and the strata appear to have been altered by eruptive rocks.

---

[1] Jahrb. v/h. M. 1879, I. p. 58–77.

Near cape Gangsa fine and coarse-grained sandstones alternate with light-coloured and variegated shales; the same is the case on the islands Tjebeh and Pagor Antimon, and the the hill-range Mangkol, south of the mouth of the river Kandawangang. Mount Kedio, east of cape Gangsa is similarly composed, excepting that argillaceous sandstones are also found there.

Again, in the basin of the river Kandawangan a hard sandstone is mentioned as alternating in some places with variegated shales (above Penkajasing, Mount Runei Atawan); while between Marau and Kandawangan, an agrillaceous quartzose sandstone is said to occur.[1]

The strike of the slates is only known in two places: on the island Karimata it is N.E. and S.W., and the same strike was observed in the bed of the river Labu (a tributary of the river Kandawangan); dip, 60° to the S.E.

Dykes and Veins.

Among the veins that traverse the slates the most numerous are the quartz-veins: one of thirty metres thickness crosses the river Pesaguan. Sometimes these veins contain brown ironstone (river Kandawangan). The granites are also often traversed by veins, *e.g.*, a quartz-vein with brown-ironstone (Island Karimata), and small veins of micaceous hæmatite (Island Mentigi). It is an interesting fact that at one place, on the river Ketate, the diorite itself is traversed by a dyke of granite. Pyrites occur on the contact faces.[2]

Dykes of eruptive rocks also traverse the slates. For example, granite dykes, on the island Karimata; and a diorite dyke, near the point where the river Labu flows into the river Kandawangan.

Ores.

The following ores occur:—Gold. The alluvial deposits

---

[1] Jahrb. v/h. M. 1880, II. p. 7 and the accompanying map. [2] Ib. 1887, p. 7.

surrounding the mountains indicate where the ore should be sought in place.

Pyrites, micaceous hæmatite, and hæmatite are found in disseminated grains, in cavities, or in small veins in the old rocks.

Galena and zinc-blende occur in slates containing disseminated pyrites.

"Mountain-Formation" in the Basins of the Melawi and Upper Kapuas.

Our information with regard to the structure of the "mountain-formation" in this part of West Borneo is very sparse.[1]

Crystalline-schists and massive rocks constitute the "mountain land." Mica-schists, hornstones, syenites, and granites form the northern declivities of the south-western mountain-chain, and the same rocks were found as pebbles by Schwaner near Serawai.

Near the sources of the tributaries of the river Melawi, which lie more to the west, the same "mountain-formation" is found, namely, mica-schist and granite. These rocks are much traversed by veins of quartz, containing pyrites and zinc-blende; they also contain magnetic and specular iron-ore.[2]

The granite-mountains Burni and Blungei, south of the Kapuas, and others in the neighbourhood of Tajan, are also out-liers.

---

[1] For our information we have Schwaner chiefly to thank; further, some specimens were collected by the natives in the rivers belonging to the Melawi, and sent to the Mining-Engineer Van Schelle (W. 54); then there are Everwyn's notes (W. 39), and the geological map of Von Gaffron (B. 39); and finally the investigations in the basin of the Upper Kapuas (Everwyn and Van Schelle, W. 42). See Everwyn's geological map in the Jaarboek v/h. M. in N. I. 1879, I.

[2] Rolled pebbles from the rivers Kalang, Ebong, Ella, Spauk, Sekompai, Kenebak; Jahrb. v/h. M. 1883, II. p. 82.

We have already spoken of the structure of the "central nountain *massif*," from which the Kapuas takes its source, ,nd also of the "mountain-land" near the sources of the Melawi.

From this point a mountain core seems to extend towards the west, forming the eastern divide between the Kapuas and the Melawi. Granite occurs in the basin of the Bojan (tributary of the Bunut), about thirty-five kilometres south of the Kapuas; while mica-schist and quartz-schist have been found among the alluvial and diluvial pebbles. Similar pebbles were found by Everwyn in the river Selibit (= Mentiba), a tributary of the Bunut.[1]

Dykes and Veins.

Nothing known.

Ores.

Gold in quartz-veins containing iron-pyrites; also copper, cinnabar, galena.

Age of the Eruptive Rocks in West Borneo.

The age of the granites varies; for granite-porphyry and micro-granite occur as dykes in the ordinary granite. A part of the granite is post-Devonian, as it forms dykes in the "old slate-formation." Whether another part is older than this has not yet been determined.

The diorites and granites appear to be contemporaneous, as granite appears in dykes in diorite, and *vice versa.*

The diorites are certainly post-Devonian, as they occur as dykes in the old slates, as also do the diabases and melaphyres.

The gabbros are probably younger than the slates.

---

[1] Jahrb. v/h. M. 1883, II. p. 82.

North Borneo.

Our information respecting the "mountain-formation" of Sarawak, Brunei, and Sabah, is still very defective. The available data indicate a similar structure without giving many details. The mountainous portion of the country is composed of crystalline schists and Devonian beds together with various granitic and dioritic eruptive rocks. What the age of the eruptive rocks is in this part of the island we have no means of judging. The information available up to the present is as follows. The mountain-chain forming the boundary of Sarawak, consists of granitic rocks and old crystalline schists. Near cape Datu the formation consists chiefly of dark bluish-grey schists, traversed by veins of quartz containing pyrites. These form lines of low hills.[1] The Gading range on the left bank of the river Lundu consists of granite.

In the drainage-area of the upper Sambas river the highest hills (200 to 300 metres) of the boundary-chain consists of granitic rocks flanked on both sides by a narrow strip of old dark-coloured clay-slates. These slates are also penetrated by quartz-veins which apparently contain no gold, although the surrounding Diluvium and Alluvium are rich in the noble metal.[2] Dark-coloured clay-slates interbedded with quartzites occur in the Upper Sikajam district close to boundary of Sarawak.[3] Further north in the upper district of the river Labojan, near the boundary with Sarawak, the boundary chain north of Lake Seriang consists of old slates traversed by veins of quartz.[4]

Concerning the mountain-chain which forms the boundary of Sarawak east of E. Saribu-Saratus, we have no information. The non-occurrence of alluvial gold in these districts indicates that the "mountain-formation" can be here of

[1] Everwyn H. 1879, I. p. 81.
[2] Jahrb. 1883, II. p. 85 to 90.
[3] Jahrb. 1884, I. p. 125.
[4] Ib. 1880, II. p. 37.

o great extent, and that perhaps it only forms a few nall "mountain-islands."[1]

The border-land of Brunei is also unknown to us; but ranite is said to occur in the upper drainage areas of the imbang, in the Batuputan line of hills.[2]

Of the Sabah district we only know, in general, of what rocks the mighty mountain-core Kinabalu and its spurs are composed. Kina-balu consists, according to St. John, of much altered syenitic granite, great blocks of which lie on its flanks. It is much penetrated by quartz-veins.[3] A similar report is made by the Italian travellers, Bove[4] and Giordano,[5] namely that the great mass of Kinabalu consists of gneiss and granite. R. M. Little says the same.[6]

Pebbles of older rocks are also mentioned as occurring in the rivers which take their source in this mountain. Thus, in the upper part of the river Tampasuk (Kadamajan), Little[6] found pebbles of serpentine, quartz, granite, and hornblende Peltzer mentions the occurrence of blocks of granite and quartz in the same river-bed, above Ginambur; and, in the Penekok valley, granite, serpentine, syenite, sandstone (Devonian), and black river-sand.[7] Serpentine and vein-quartz containing iron pyrites, are mentioned as occurring in the river Marudu. In the neighbourhood of the rivers Tartipan (Maruda Bay)[8] and Labuk, Hatton[9] mentions a hilly land, consisting of

[1] Motley mentions mica from the Upper Rejang river and Kinabalu. Report on the geological phenomena of the island of Labuan. *Towns of the Indian Archipelago.*

[2] Spenser St. John, N. 9.

[3] St John, N. 10, 1862, p. 220.

[4] Bove, N. 20, p. 292.

[5] Giordano, N. 19, p. 194.

[6] *British North-Borneo Herald,* 1887, No. 7, pp. 155 and 153.

[7] Peltzer, N. 32, p. 392.

[8] The serpentine formation of Maruda Bay seems to be continued on to the neighbouring island of Banguey. Its north-easterly mountainous portion, with a peak of fifty metres height, consists of several varieties of serpentine. Giodano, N. 19, p. 209.

[9] F. Hatton, N. 48.

serpentine; at the foot of Tambayukon (7,000 ft. high), he found pebbles of syenite, greenstone and serpentine; at Bendowen, grey slates (*in situ*) veined with quartz; at Siposu, a decomposed rock, composed of quartz and mica; and in the river Labuk, pebbles of quartzite and mica-schist. The granitic mountain-ridge of Kina-balu is, therefore, surrounded by crystalline schists (perhaps, in part, of Devonian age). South of Kina-balu there appears to be another mountain-island. In its upper course the Kinabatangan river appears to traverse a district 2,000 to 6,000 feet high, consisting of old rocks. Above Pinunguh, where the stream divides into its two main branches, Daly[1] found boulders of granite, mica-schist, quartzite, pyrites, together with sandstone and coal. Old rocks have been also found on the upper Segamah river: the "mountain-formation" must therefore occur here.

Granite-blocks are mentioned as being scattered along the northern shore of Sibuko Bay. And not far from the coast, towards the east, is a mountain about 2,000 feet high, with gently arching flanks; while in the direction of the river-mouth and in the immediate neighbourhood of the sea stands a mountain of bold contours and noble proportions, being 3,000 to 4,000 feet high. Reasoning from analogy, we would expect to find here a rich coral-formation, while the granite lying about in blocks, points to the presence of the "mountain-formation."[2]

Along the west coast run three parallel mountain-chains, of which the third and highest consists of the "mountain-formation. Peltzer[3] found (in the Kimanis river) in S. Pampan, granite pebbles derived from this chain. In the river Padas, however, Daly[4] only mentions sandstone. The course of the granite would thus seem to be interrupted in places; it probably occurs only in "islands."

---

[1] Daly, N. 51, p. 7.

[2] J. Oesterreicher, B. 31, pp. 216 to 222.

[3] Peltzer, N. 33, p. 380.

[4] Daly, N. 51, p. 14.

East Borneo.

Here, again, also our information is very deficient, and, at the est, only of a general character. The "mountain-land" of the southern states, Kusan, Tanah-Bumbu, and Passir, is constituted by the boundary mountains of South Borneo. We only know the geological structure on the South Borneo side, since Von Dewall, the only traveller in the mountainous parts of these states, tells us nothing of them. But the gold and diamond fields in these states give us an indication of their geological structure, and of the character of the rocks from which these minerals are derived. In 1885 Hooze found in the rivers that flow into the strait of Laut, serpentine, quartz, diorite, and quartz-schist; and again in the Bay of Pamukan, on the right bank of the river Sampanahan, he found old crystalline rocks.[1]

Of the island of Laut we only know that the south-eastern part is mountainous, thus having a similar structure to the remaining mountain-land: on the shore opposite the river Kusan, there are some cliffs of mottled serpentine of a dark blackish-green colour.[2] This serpentine, which underlies the coal-beds, is continued on the western side, as far as the island of Sebukut, and, on the other side, as far as the Bay of Pamukan.[3]

Schneider states that in the south-east of the island there are mica and hornblende rocks in endless variety. This is not improbable, but I could find no written reference to them.

We have no proper information regarding the structure of the highlands of the states, Kutei, Berau, Bulongan, and Tidung. Travellers have only traversed parts of the first-named state, while the in-lying lands of the remaining states are quite unknown.

---

[1] Java Courant 1885, Verslag v/h. Mijnwezen IV. [2] De Groot S. 23, p. 62.
[3] Java Courant 1885, II.

That the mountain-land here possesses a similar geological structure can be concluded from its analogy with the remaining parts of Borneo, and there is besides indirect evidence in favour of this assumption. Gold is found in the interior;[1] further, Schneider[2] mentions that he has often obtained specimens of gold-bearing quartz from Kutei, from which can be concluded that schists and eruptive rocks traversed by veins exist there, as only these rocks contain gold in Borneo. The same author[3] also states that gneiss predominates in the boundary mountains of Kutei. The source of this information is unknown to me.

Similarly it is known that gold is washed in the upper reaches of the rivers Segah and Kelah (tributaries of the river Berau.)[4]

On the southern bank of the Pantei, mouth of the river Berau, are three small isolated hills, Padei, Samira, and Suaran, consisting of quartzite.[5]

Of the geological structure of those spurs of the mountain-land that run towards the coast, we at present know nothing. They form the divides between the rivers Sibawang, Bulongan, Segah, and Kelai. That the mountain-formation is represented here, is shown by the occurrence of galena at a place five days' journey up the Segah river.

The northern boundary of the State Kutei and the mountain Sankulirang, in the neighbourhood of the coast, appears from its height (2,000 to 3,000 feet),[5] and especially from that of the mountain Batu-tempatung (1,600 metres),[6] to consist, at least in part, of the "mountain-formation." Whether it occurs in great masses, or simply in "isolated patches," is not known.[7] It extends as far as Cape Mangka-liat.

The boundary mountains between Kutei and Passir,

[1] Bock S. 44.
[2] Schneider B. 30 p. 133.
[3] Ib. B. 30 p. 122.
[4] Gallois E. 9; Hageman E. 7; Von Dewall E. 6.
[5] Hooze E. 13, p. 15.
[6] Schouw Santvoort E. 11.
[7] Verbeek S. 41.

nd the remaining southern states, appears to consist of Tertiary "hill-land" with a few higher mountains, as for ıstance, the Balik-Papan, which probably belongs to the mountain-formation."

Microscopic and Chemical Description of some of the Rocks.

Hornblende-schist, (Riam Kanan, South Borneo).

SiO_2	50.53
Al_2O_3	21.20
Fe_2O_3	17.80
CaO	6.13
MgO	1.21
K_2O	0.93
Na_2O	1.28
Water	1.20
Sp. gr. = 3.02.	100.28

Under the microscope crystals of quartz and hornblende are visible.

Quartzite, (Mount Tamhan, South Borneo).

SiO_2	88.8
Al_2O_3, Fe_2O_3	5.5
CaO	1.7
MgO, K_2O, Na_2O	2.0
Loss on ignition	2.0
	100.0

Microscope: turbid ground mass with small brightly polarising quartz granules and small particles of pyrites.

Olivine-gabbro[1] (river Tiwaan, South Borneo).

SiO_2	46.20
Al_2O_3	21.07
Fe_2O_3	4.46
CaO	16.26
MgO	9.52
Na_2O	0.64
Loss on ignition	2.53
Sp. gr. = 2.93.	100.68

[1] Verbeek S. 41.

Microscope: striped fresh plagioclase, fissured brown diallage, accompanied by a light-green alteration product; olivine, of which grains can be still clearly made out in the dark-green or black serpentinous alteration product. Structure granular.

Serpentine (Mount Batara Bulu, South Borneo).

SiO_2	40.05
Al_2O_3	0.66
Cr_2O_3	0.54
FeO	8.01
MnO	1.55
CaO	0.96
MgO	39.08
Water	9.11
Sp. gr. = 2.82.	99.96

Microscope: grains of olivine, crystals of diallage, and particles of iron-ore lying in a light-yellowish green ground mass. The first two are partly altered to serpentine.

Diorite[1] (Mount Sumat, South Borneo).

Si_2O_3	54.20
Al_2O_3	16.20
Fe_2O_3	12.54
MnO	trace
CaO	6.87
MgO	3.42
K_2O	1.40
Na_2O	2.92
Loss on ignition	3.07
	100.62

Möhl[2] describes the diabase from Mentagarioni (?) in South Borneo thus: "in a compact ground mass lie abundant oligoclase crystals (up to five mm. in length), partly decomposed; further, augite, of which only a few fragments remain, the rest having been altered into seladonite and ilmenite in irregular patches up to eight mm. in size."

He also describes bronzite from Sampit in South Borneo.

Gabbro (Upper Sikajan river, West Borneo). Microscope: turbid plagioclase, diallage, biotite, hornblende, olivine grains partly altered to serpentine, apatite.[3]

---

[1] Verbeek S. 41. [2] Möhl S. 42, p. 790. [3] Van Schelle W. 62, p. 127.

Formations Older than the Tertiary.

Until the eighties no formations older than the Tertiary (with the exception of the "old slate-formation") were known in the whole of Borneo. The reports of the different travellers led one to suppose that the "mountain-formation" was immediately followed by the Tertiary "hill-land."

Thus Schwaner writes of the south-western central mountains: "Loose sandstone-formations, alternating with clays and shales, rest on the granite which forms the main mass of mountain-formation in the north and south."[1]

And Verbeek: "Older sedimentary-formations are entirely absent on the river Riam-Kiwa; the Tertiary strata overlie phyllites and older eruptive rocks."[2]

Everwyn writes: "In West Borneo no proof has been furnished that rocks of the Secondary period occur. If they are really present, a geological study of the boundaries of the Tertiary basin of the Kapuas would give the best proof of their existence. At the same time many circumstances show that the Tertiary beds lie directly on the old Neptunic strata."[3]

But in the eighties the evidence increased for the existence in Borneo of other sedimentary formations besides than the Tertiary and the "old slate-formation." Thus Chalk was proved to exist in Western Borneo, and the existence of Carboniferous Limestone was made likely in the northern parts of the island.

Let us take these formations in order.

Devonian = "Old Slate-formation."

On the islands of the Malay Archipelago the oldest slates,

---

[1] Borneo II., p. 172. [2] Jaarboek v/h. M. 1875, I. p. 48.
[3] Ib. v/h. M. 1873, I. p. 97.

in which up to a short time ago no fossils had been found, are included in the so-called "old slate-formation," to distinguish them from the "younger slate-formation," which, in Sumatra, is included by Verbeek[1] in the Culm-measures. Their distribution is very extensive, as they occur on all the islands. In Borneo, they contain gold; in Bangka and Billiton, tin.

With regard to the age of these phyllites it was only known up to quite lately that they were pre-Carboniferous, as the Carboniferous strata in Sumatra are underlaid by them.

In recent years, however, fossils have been found in West Borneo, which, however, are so badly preserved that up to the present an exact determination of their age has not been made. But the fossil-evidence is not against the view that the formation might be Devonian.[2]

Although these slates are developed in considerable thickness, their upper and lower limits (the Carboniferous beds and the Crystalline Schists) are still very uncertain, and in most cases have, up to the present, not been determined.

It has already been mentioned that besides these slates, typical crystalline rocks occur in the "mountain-formation" which crops out below them. Thus, for instance, in south-eastern Borneo (Tanah-Laut) hornblende-schists, mica-schists, and quartzites are largely developed. There is no evidence for including these rocks in the Devonian formation. They are much more likely to be of Archæan age, and a part of the quartzite-schist and clay-phyllites are perhaps of the same age, while another part may belong to the Devonian.

As long as it is not possible to separate these rocks properly from one another, it is better to treat them together as I have done in the "mountain formation." The Indian

---

[1] Van Schelle also speaks of the "old slate-formation" in West Borneo in contra-distinction to the Tertiary clay slates." Jaarboek v/h. Mynwezen in N. J. 1886, II. p. 122.

[2] Jaarboek v/h. Mynwezen in N. J. 1886, II. p. 122.

Mining Engineers do the same, and treat the whole group together as "old slate and quartzite."[1]

In describing the west coast of Sumatra, Verbeek says on p. 176: "It appears to me probable on petrographical grounds that these rocks ('old slate-formation') do not all belong to the same period. But they are described together because they contain no fossils, are older than the Culm-measures, and, up to the present, have not been separated into different formations."[2] With regard to the gneiss of Sibelabu he says that there is no reason for regarding it as older than the remaining schists since there is no unconformity between them. The conclusion arrived at by this able Indian geologist is that perhaps a part of the schists are Azoic, but that the greater part is Silurian, or Devonian, or a mixture of both.

Van Schelle includes all the old slates of West Borneo (Chinese Districts) in the Devonian.[3] True crystalline schists have not, it is true, been found in this district. Clay-slates and quartz-schists, quartzites and sandstones, argillaceous sandstones and isolated beds of conglomerate belong, according to him, to the Devonian. They are pierced by granitic and dioritic rocks.

The upper limits are equally indeterminate in Borneo. Even in Sumatra it is not possible to separate the Culm-measures sharply from the slates of the "old slate-formation."[4] On the other hand, the unconformity between the Carboniferous Limestone and the old slates is clearly visible. In

---

[1] C. J. van Schelle, Mededeeling omtrent de geologisch-mynbouwkundige opneming van een gedeelte der residentie Westerafdeeling van Borneo (Jaarboek v/h. M. in N. J. 1886). R. D. M. Verbeek, Topographische en geologische beschryving van een gedeelte van Sumatra's, Westkust, 1883. R. Fennema, Topographische en geologische beschryving van het moordelyk gedeelte van het gouvernement Sumatra's Westkust (Jaarboek v/h. M. in N. J., 1887).

[2] Since found in West Borneo.

[3] Jb. v/h. M. 1886, p. 121.

[4] Verbeek, Sumatra's Westkust, p. 237, 238.

Borneo our knowledge is at present too restricted. A part of the "old slates" belongs, perhaps, to the Culm-measures in districts where the Lower Carboniferous formation appears to be developed (North Borneo, and especially Sarawak).

Carboniferous Formation.

The earliest information regarding the presence of a Carboniferous formation in North Borneo is derived from A. H. Everett.[1] He mentions the occurrence in Sarawak proper of an old compact bluish (Palæezoic) limestone, and of thick beds of a sandstone, in part underlying, in part overlying the limestone, associated with beds of conglomerate and slates.

This thickly-developed formation is, in its turn, overlaid by much younger slates.

The beds of this formation are occasionally turned up on edge, and are much denuded, so that a considerable time must have elapsed before the deposition of the more recent sandstones. The sandstones form isolated table-lands 1,500–5,000 feet high, and are traversed by eruptive rocks, as are also the limestones. The latter, which reach a height of 200–1,200 feet, form old fringing reefs, and are in places rich in fossils, among which are encrinites, which have not yet been determined. The ores (of mercury and antimony),[2] are related to these eruptive rocks.

Everett distinguishes between sandstones of two ages, but groups all the eruptive rocks together, placing their eruption after the deposition of all the strata, with the exception of the Recent. Everett also ascribes a similarly youthful age to the ores (of mercury and antimony), which, however, is not correct. Further, he makes no difference between the Tertiary coral reefs and the old limestones. At the same time it is quite possible to make use of his descrip-

[1] Everett, N. 23, p. 2, and side notes. [2] Everett N. 29, p. 2.

tions by comparing them with the geological relations of other districts.

The geologist, Frank Hatton,[1] also speaks of an "old sandstone-formation" in north-east Borneo—namely, in Sabah. In travelling over the Miruru District, on a journey to the interior from the coast, he passed over a great series of hills consisting of plutonic and metamorphic rocks, and again reached a sandstone-formation. He was, however, of the opinion that this sandstone of the interior is of much greater age than the coast (sandstone) formation, which is of much later date. Similarly he mentions, in several places, the different types of limestone.[2]

The first chronological determination was made by Tennison Woods.[3] He found a Vertebraria and Phylotheca australis among the fossils of Sarawak, and a Fenestella and a Stenopora in the limestone of the Upper Kinabantangan District. He considers this limestone, therefore, to lie between the Devonian and the Coal-measures (*i.e.*, Carboniferous Limestone).

We have thus in Northern Borneo to do with an older sandstone and limestone formation, which differs in many respects (geotectonic and petrographical) from the Tertiary sandstone and limestone formation (Eocene, Stage α and γ of Verbeek).

The older sandstone is coarse-grained, and not very ferruginous: it rises to 4,000 feet; while the Tertiary sandstone, as far as is at present known, only constitutes a "hill-land" of 200–300 feet.

The older limestones are characterised by their hardness and bluish colour; they do not contain fossils, with the exception of isolated localities (Sarawak), where fossils are nume-

---

[1] Frank Hatton N. 48, p. 192.

[2] Verbeek also mentions the probable occurrence of Carboniferous Limestone in Borneo (Sumatra's Westkust, p. 314.)

[3] Wood N. 47 and 52, p. 233.

rous, and the rocks are traversed by numerous calcite-veins and by ore-bearing quartz-veins. In Sarawak the veins mostly contain antimony; in Sabah, iron- and copper-pyrites. Thus, for example, the compact bluish limestone, which crops out in the Upper Pengapugon river, is traversed by quartz-veins with iron-pyrites; and Hatton found quartz-pebbles containing pyrites in the river-bed near Timbang Batu.[1] Further, the older bands of limestone are full of caves, and contain edible bird's nests, like the Tertiary coral-reefs; but while the latter only attain a height of 200–300 feet, the former reach as much as 1,200 feet.

In places greenish or reddish slates are intercalated in the limestone (Pampan and Sabah), or the latter alternates with sandstones. As a rule, however, the limestone underlies the sandstone.

But while the Carboniferous formation is clearly marked off from the Tertiary beds, this is not the case with its lower boundary.

Even in Sumatra, of which the western half is geologically comparatively well-known, it is only possible to separate the Carboniferons Limestone as such. The Culm-measures, on the other hand, are, in many cases, not to be distinguished from the "old slate-formation:" one is often in doubt as to which formation the rocks in question are to be referred.[2]

This is even more the case in Borneo, where this formation is scarcely known. There is much doubt as to where, in any given case, a quartz-schist or slate belongs, and the same is the case with the old sandstone. In Sarawak, which with the "Chinese Districts" of West Borneo, forms an immense mountain-island, the sandstone (which contains quicksilver), is certainly Devonian, as Van Schelle makes it in West Borneo. But the age of the immense sandstone formation in Brunei and Sabah is at present undecided; it

[1] Fr. Hatton N. 48. [2] Verbeek, West Coast of Sumatra, p. 237–238.

is probable, however, that it belongs, in great part, to the Carboniferous.

The Carboniferous formation is of great extent in Northern Borneo. It appears to extend from Sarawak to the Bay of Murudu, and to be greatly developed in North-eastern Sabah, and in the in-lying States of Tidung and Bulongan.

The Carboniferous formation has already been described for Sarawak proper; where the Carboniferous Limestone contains antimony. It must, however, also occur in Eastern Sarawak (upper basin of the Batang-Lupar and Redjang),[1] for antimony ores are found there. These have been recently worked, and are probably of the same age as the antimony ores in Sarawak proper, whence may be drawn *a posteriori* the conclusion that the rock in which they occur is also Carboniferous Limestone.

In Brunei, lying to the inland side of some low sandstone hills (Tertiary), are some limestones alternating with sandstones, and forming elevations of 2,000–8,000 feet, *e.g.*, Mount Malu (8,000 feet), which was ascended by St. John in the fifties.[2]

From here the Carboniferous formation appears to extend as an immense band along the coast as far as the north-eastern point; it is separated from the sea, however, by a parallel strip of Tertiary hills.

Thus the river Padas cuts through a mountain chain, running along the coast in a N.E. and S.W. direction, in which is Mount Jumma (4,000–5,000 feet high), composed of a highly-inclined sandstone formation; the river Lawas also traverses a high chain of limestone mountains in its upper and lower courses.[3]

Peltzer[4] mentions the mountain and hill chains that have to be passed before the great plains of Sabah are reached.

---

[1] Everett N. 23, and his marginal notes.

[2] St. John N. 9 and N. 10.

[3] De Crespigny N. 14 and N. 15.

[4] Peltzer N. 33.

The first chain of hills (on the river Kimanis), the G. Sawatan, is only 500 feet high; the second, G. Lampiau, 1,500 feet high, consists of sandstone, basalt, quartz, and limestone; and the third, the chain G. Panimbahan, 2,500 feet high, consists of old rocks, granite, etc.

While the first range of hills is probably Tertiary, the second must, according to the description given, be Carboniferous: for it consists of sandstone and limestone, traversed by veins of quartz and dykes of diabase (basalt ?).

On the western slopes of the Kina-balu *massif*, Peltzer mentions sandstones and limestone traversed by quartz-veins; and the south-western base of Kina-balu consists of a limestone-plateau, 3,500 feet high (Carboniferous Limestone ?).

The district to the west of Kina-balu is described by St. John[1] similarly to Peltzer. The sandstone hills increase in height towards the interior. Near the Marei-Parei mountain-core (belonging to Kina-balu) St. John found, besides hard sandstone, hard black slates and much greenstone (diabase ?). The main core consists of hard sandstone, black slate, and other rocks unknown to St. John. Then follows decomposed granite. That limestone is not altogether absent is shown by a piece of limestone broken off in the Kalupis valley (upper course of the river Tampassuk). Mount Kalawat (1,000 feet high) has on its summit a small plateau, which, may be taken as a tectonic indication of limestone.[2]

Again, Little[3] searching, a few miles from Kiau, in the upper basin of the river Tampassuk, found among other boulders, some of limestone (probably containing copper-pyrites); and, lower down the river, he found the limestone *in situ*.

In the neighbourhood of Kaliga Point, the old limestone-hills approach the coast, and extend thence to Sampanmangio

---

[1] St. John, N. 10. [2] Bove N. 20.
[3] See *British North Borneo Herald*, 1887. N. 7, p. 153.

Point.[1] They re-appear in the Banguey Islands, and in the neighbouring small islands. Limestones, showing disturbed stratigraphical relations, occur here, alternating with limestones, and traversed by veins of pyrites and copper-pyrites.[2]

In the western part of Sabah a large extension of the limestone-formation is mentioned by Hatton.[3] These limestones possess all the properties of the older limestones, and contain ores (which, up to the present, have been found to contain only traces of iron and copper pyrites; while antimony has been sought for in vain); and Gueritz[4] mentions that the silver and antimony-bearing formations that occur in Sabah, are also present in Sarawak. These formations are largely developed to the east of Kina-balu; further, in the upper basin of the Kinabatangan, and again south of it.

It has already been mentioned that the Dent Province, of which so little is known, and the States of Tidung and Bulongan probably contain Carboniferous Limestone. Thus, in the immediate neighbourhood of the sea, in the Bay of Sibuko, there is a bold range of mountains (3,000–4,000 feet), where, by analogy, the coral-formation[5] should be strongly developed.

Chalk Formation.

It was in the eighties that chalk fossils were first found in West Borneo.[6] The Indian Mining Engineer, Van Schelle, found them near Noa, on the river Tungu, near Kroah, on on the river Melawi, and near Sajor on the river Seberuang.[7]

The determination of the fossils from the first locality,

---

[1] Frank Hatton N. 48.

[2] Giordano N. 19.

[3] Frank Hatton N. 48.

[4] Gueritz N. 21.

[5] Oesterreicher B. 31, p.216.

[6] In S. Borneo, Kloos (B. 20) had already recognised Cretaceous forms from Riam Kiwa, Banju-irang, and Kalangan, especially Phaculina Faujasii and Cancer Desmaresti, which he refers to the Senonian.

[7] Verbeek W. 60.

which were badly preserved and few in number (*e.g.*, Cyrena, Corbicula, Melania) is not quite reliable; but, according to Dr. Böttger, they appear to belong to Stage *a*, Eocene, the only strata in Borneo in which fossils of fresh and brackish waters are known. The fossils from the second locality belong probably to Stage *β* of the Eocene.

With regard to the fossils on the Seberuang river, Everwyn[1] described, in the fifties, grey marls and greenish-grey sandstone beds containing numerous nummulites.

In 1872, Schneider collected fossils on the same river, in a dark-grey limestone. Among these Fritsch found two patellinas, and suggested that these beds were possibly of Cretaceous age, with which the occurrence of Patellina appears to agree.[2] Among the foraminifera of the same locality, Van Schelle found no nummulites, but numerous patellinas, which were probably regarded formerly as nummulites.

The Sajor fossils are regarded by Böttger as Senonian (Goniomya, Trigonia, Vola), and Professor Geinitz also includes them after a preliminary examination in the Upper Chalk.[3] The fossils are the following:—

Vola cf. quadricostata Bronn.	Pholadomya cf. designata Goldf.
Modiola cf. capitata Zittel.	Natica cf. Gentii Sow.
Lyonsia cf. Germari Gein.	Natica cf. lamellosa Röm.
Trigonia cf. limbata d'Orb,	Avellana 2 sp.
Panopæa cf. Gurgitis Bgt.	Hemiaster cf. sublacunosus Gein.
Panopæa cf. mandibula Sow.	Hemiaster cf. Regulusanus d'Orb.

Also:

Ostrea	1 sp.	Cyprina	1 sp.
Spondylus	1 ,,	Cardium	1 ,,
Pecten	1 ,,	Astarte	1 ,,
Lima	1 ,,	Venus	1 ,,
Avicula	1 ,,	Goniomya	2 ,,
Trigonia	1 ,,	Natica	1 ,,
Arca	2 ,,	Patellina	1 ,,
Tapes	1 ,,		

[1] Everwyn W. 39, p. 25. [2] Everwyn W. 39 p. 246. [3] Geinitz W. 61.

How far this formation extends is uncertain. Up to the present only its existence has been proved, but this is in so far of great consequence, as it is the first proof of the existence of Mesozoic strata in the Indian Archipelago.[1]

(III.) THE GEOLOGY OF THE "HILL-LAND" (TERTIARY).

South Borneo.

Distribution.

The Tertiary "hill-land" forms a belt round the "mountain-islands" and accompanies it throughout its whole extent. Beginning in Tanah-Laut, the south-eastern point of the island, it is continued along the edge of the mountains; and, on the north side of the Pramassan Alai mountain-core, it forms the chief boundary-land between South Borneo and the northern part of the states Passir and Kutei.

In the basin of the Barito we meet Tertiary strata near the junction with the river Montallat, forty-five geographical miles from the coast. The more one goes to the west the nearer does the "hill-land" approach the southern coast.

On the Kapuas river it is found near the union with the river Kawattan (1° 20′ south latitude) at a distance of thirty geographical miles from the coast. On the river Kahajan it begins near Passa Tegara, in the same latitude as on the Kapuas, while on the tributary Rungan it appears more to the north, above Udjong. On the river Katingan "hill-land" is found near Buntut-Bentang (1° 25′ south latitude), twenty-five geographical miles from the coast.

In the western river-basins it reaches in some places to the coast, as, for instance, in the Gulf of Sampit in Kota-

[1] Professor Martin considers that the age of the beds may be regarded as Cretaceous only when it has been shown that the tropical chalk fauna may be determined as such by the European standard (B. 45, p. 23).

ringin, near Cape Silaka and Sambar (the latter being the south-western point of the island).

It has already been mentioned that the "hill-land" not only succeeds the "mountain-land" but also occurs in it, connecting the separate chains, and also that it surrounds isolated mountain-chains, for instance, the Pararawen chain.

From a geotetonic stand-point the Tertiary "hill-land" only forms isolated ranges, the height of which rarely exceeds 200 to 300 feet. Towards the border of the mountains the hills become higher (Eocene); towards the plains their height diminishes, and they form only low ranges (Miocene).

Tertiary near Pengaron.[1]

The first investigation of the Tertiary formations in South Borneo, and indeed in the whole island, began on the river Riam Kiwa.

Horner and Schwaner first navigated this river, and the latter discovered there the coal-seams which led to the opening of the coal mines on the Riam Kiwa. Pengaron itself became now the starting point for detailed investigation of the coal beds occurring in the Tertiary, on the part of the mining-engineer, C. de Groot, and the geologist, Verbeek.

As has already been mentioned, we have the latter to thank for our exact knowledge and division of the Tertiary formation. He took Pengaron as a starting point, and for this reason we will describe the Tertiary in the districts of Riam Kiwa and Kanan, as the Tertiary-formation of Kanan.

On the river Riam Kiwa the Tertiary (Eocene)[2] occurs, according to Verbeek, in three stages,—α = sandstone-stage, β = marl-stage, γ = limestone-stage.

---

[1] For the views of Müller, Horner, Schwaner, and C. de Groot, see *Historical Part.*

[2] See the determination of the age, and varying views thereon.

The Sandstone-Stage.—(*a*).

This comprises the lowest beds, and is so called on account of its predominant sandstones. From a technical standpoint, it is the most important, as it contains the "Indian coal seams."

Petrographically it consists of an alternation of sandstone, shale, carbonaceous shale and coal.

The sandstones, usually of a white or yellow colour, always contain flakes of silvery-white mica: the cement is argillaceous. They can often be crumbled with the hand, but often show a greater firmness. Probably they are derived from mica-schists.

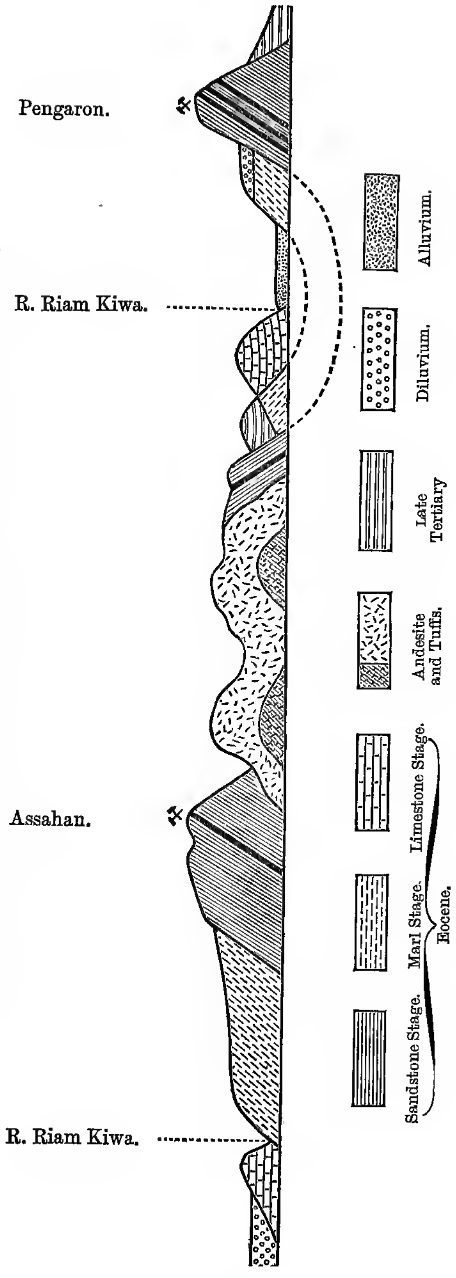
The fossils only comprise a few leaf-impressions. The grey shales are often laminated and soft, but sometimes unlaminated and hard. They often contain leaf-impressions. By the addition of carbonaceous particles, they pass into carbonaceous shales. Some of the beds contain nodules of clay-iron-stone, the interior of which is usually hollow, and contains stones or crystals of brown iron-stone.

The coal which occurs near Pengaron, in nineteen seams, is compact, black, resinous, and contains very little pyrites. (For details see "Coal.")

Animal remains are found only in the shales and "letten." Especially to be mentioned here is the Grena Borneensis, which occurs abundantly only in stage *a*. Nummulites do not occur at all.

The thickness of the sandstone stage is 159·70 metres; which is made up thus—

Nineteen coal seams -	10·66	metres.
Sandstones, - - -	43·54	„
Shales, - - - -	105·50	„
	159·70	„



SECTION THROUGH THE COAL MINES ASSAHAN AND PENGARON (AFTER VERBEEK)

The strike is north-east, parallel to the mountain-chain; the dip is about 35° to the north-west. The sandstone-beds are much pierced and faulted by younger eruptive rocks.

(β). *Marl-stage.*

Among the yellowish-white sandstones are the following beds, arranged in order:—

Bluish-grey "Letten," and shales without fossils.

Bluish-grey "Letten," with Crustacean remains.

Grey-marl, with marl-clay nodules very full of fossils.

These concretions are often of the size of a man's head, and are sometimes siliceous, and moderately hard. The interior is often fissured, the radiating cracks filled with crystallized calcite. They include a whitish-grey bed of marly limestone, ·3 metres thick, filled with orbitoides and some nummulites (Nummulites Pengaronensis.) This is called the first Nummulite Zone.

The percentage of lime in these beds increases from below upwards. The lowest beds usually do not effervesce with acid, and the richest bed in lime is the marly sandstone.

The thickness of the marl-stage is about 250 metres.

(γ). *Limestone-stage.*

This stage consists of a hard whitish or bluish limestone rich in fossils, and contains numerous nummulites.

Some beds are in places filled with fossils, and in others free from them.

Generally the limestone is somewhat argillaceous, and usually it also contains siliceous concretions, which project from the limestone as flints. They contain the same fossils (nummulites and corals) as the limestone. The fossils consist in great part of calcite, and are difficult to remove from the limestone. Among them are many corals, sea-urchins, lamellibranchs, gasteropods, orbitoides, and nummulites.

The limestone-stage forms the coral-reef which extends from Martaraman on the river Kiwa as far as the Gunong Batu Hapu, running parallel to the G. Bobaris.

Isolated parts are also found between the river Riam Kiwa and the Mangkauk. The thickness of this stage is, near Pengaron, twenty metres; near G. Batu Hapu, ninety metres.

In the last-named mountain there is a large cave 800 metres long, and 150 metres wide, with numerous stalactites. The cave lies near Rantau Budjur.[1]

The Andesites and their Tuffs.

The Eocene strata are pierced in numerous places by eruptive rocks, the intrusion of which has disturbed their bedding as may be seen between Blimbing and Tamban near Pengaron. They form ridges 100–250 feet high, extending usually in a north-east and south-west direction (*i.e.*, parallel to the strike of the mountain-chain), but sometimes deviating from this. The rocks composing these hills appear to have been erupted through fissures, and do not form mountains or mountain-ridges which have been produced by successive growth, as in the case of a volcano.

The eruptive rocks have, for the most part, affinities with the greenstones, as well as with the trachytes. They are nearly always porphyritic, large crystals of plagioclase, hornblende, or augite being scattered through a compact ground-mass. They are hornblende-augite-andesites.[2]

These andesites are always accompanied by wide-spread deposits of tuffs and tufaceous conglomerate. Large, round, and angular pieces of andesite and shale, are imbedded in an andesitic paste, and are in part melted down. The ground mass of this coarse tuff-conglomerate is of a reddish to reddish-

[1] Verbeek S. 41, p. 67, and De Jongh S. 35. See *Cave-explorations.*

[2] Verbeek prefers to call them by this name, as they scarcely ever contain olivine, and basalts proper do not occur, according to him, in any part of South Borneo.

brown colour, and contains 46½ per cent. of water. It is very hard, has a weathered appearance, and is uniformly granular. The latter point distinguishes it from the porphyritic andesites. The hornblende-andesite of the Sungei Pinang is a greyish rock, with porphyritic crystals of plagioclase and dark scales of mica. The hornblende-andesite of Riam Balei, near Lok-besar, contains crystals of felspar and blackish-green horn-blende imbedded in dull grey ground-mass.

The andesites pass into the tuffs and tuff-conglomerates, and are often not to be separated from them. They are only visible in the river sections, being always covered by a layer of tuff, of which, also, the tops of the hills are composed.

The age of the andesites has not been exactly determined; since, up to the present, no fossils have been found in their tuffs; since, however, they have also pierced the upper limestone-stage (Nummulitic Limestone), they are probably of Miocene age. Their tuffs are of the same age, as they are not sharply separated from the lavas, but pass into them.

Contact phenomena between the eruptive and the surrounding rocks are visible in several places. Fragments of sandstone are imbedded in the andesite at their boundary.

The hornblende-andesite of Riam-balei near Lok-besar encloses fragments of baked sandstone; and the tuff-conglomerate of Attiim contain pieces of burnt shale; similarly the shales near Battong-Bedara in the neighbourhood of the augite-andesite are hardened and the cracks filled with calcite.

On the Riam Kanan, in the neighbourhood of the G. Djabok, is a sandstone breccia, which looks as if it had been baked; and near Tiwingang there is a fine-grained breccia, consisting of small pieces of quartz, mica-schists, and soft black grains of weathered augite. It is a tuff-breccia of augite-andesite.

Late-Tertiary Formations.

In contra-distinction to the early Tertiary formations (Eocene), Verbeek calls the sandstones and shales which lie above the andesites, late Tertiary (" Jung Tertiär").[1]

A lower band of shales and a upper series of sandstones can be distinguished.

The shales are either pure, thinly laminated, soft shales of a blue-grey colour, or they are greenish grey to grey, marly slates of greater hardness, sometimes containing mica-flakes and sand. These are not thinly laminated.

Sometimes they alternate with pebbly beds (quartz and eruptive rocks), as, for instance, at a place not far from the mouth of the Tabattan.

The upper sandstones, which are of a yellow, red-brown and green colour, consist of quartz-grains, dull white particles (probably decomposed felspar), and isolated white flakes of mica. They mostly contain some lime, and are, therefore, "marl-sandstones." The red colour is produced by oxide of iron, the green by glauconite, or by weathered augite. Often the sandstones become conglomeratic, and have a zeolitic deposit on the cleavage planes.

The greater number of the sandstones are to be regarded as sedimentary andesite-tuffs. The material of the green sandstones is derived chiefly from the andesites and their tuffs. The green sandstones sometimes pass into the tuffs, and are then difficult to distinguish from them. Between the sandstones there are occasionally beds of quartz-pebbles.

The stratigraphical relations of these rocks are not disturbed; they have a dip of from 10° to 12°.

Fossils have not been found, and the stratigraphical sequence alone shows them to be later than the Eocene.

---

[1] It is only exceptional that the shales lie directly on the mica-schists (R. Kalaän).

The thickness of the shales is about twenty metres, that of the sandstones thirty to sixty metres, the total thickness being fifty to eighty metres.

The Tertiary in Tanah-Laut.

The Tertiary formation of Pengaron extends in a south-westerly direction, parallel to the Meratus mountains, over the Gunong Djabok and Djalamadi, to Banja-irang, and even beyond this point, as has already been shown by Rant in the fifties.

The marl and the limestone stages also seem to extend to Banju-irang. C. de Groot did not find the latter stage *in situ*; but in Nangka he found flints containing the same fossils as on the river Riam Kiwa. Besides, it was known to him that the limestone-stage near Banju-irang forms hills,[1] and Van Dyk had described a Nummulite from the limestone.[2]

Further to the south the sandstone beds again occur, but the marl and the limsetone stages appear to be absent.

Intrusions of andesite also occur here, as, for instance, on the river Riam-Kanan, near Karang-intan, where the coal-seams of the hills Djabok and Djalamadi seem to be faulted by them.

Late Tertiary deposits are also present in Tanah-Laut. Up to the present they have been proved in the rivers Sebuhur and Assem-assem (see the occurrence of coal there).

As will be seen from the facts given here, our information with regard to Tanah-Laut is rather deficient, but the geological and mining researches which are at present being carried on there, promise to furnish interesting results in the course of a few years.

---

[1] C. de Groot S. 23; in the Jaarboek, p. 52 and 54.

[2] P. van Dyk, B. 13.

Remaining Districts.[1]

In the remaining parts of South Borneo, we are (with a few exceptions) only aware of the *presence* of Tertiary formations, which by many peculiarities are proved to be identical with the Tertiary of Pengaron. It will not excite wonder that we know so little on this head, when one considers the long and patient study that was required for the proper recognition and classification of the formations in Tanah-Laut; while travellers that have visited and reported on these districts have been very few.

That the hill-land in the remaining parts of South Borneo is similarly contituted to that near Pengaron, and in the Tanah-Laut is shown by a comparison of the strata.

Horner considered the strata in the Tanah-Laut (Karang-intan) and in Central Borneo to be of the same age; and from Schwaner's descriptions we are led to the same conclusion. Martin confirmed this view by a comparative petrographical study of twenty-seven specimens, made on the collections of both travellers in these districts. In this examination he also compares the rocks with the three Eocene stages of Verbeek.[2]

This has been lately substantiated by an examination of the limestone-rocks of Batu Bangka, where the same sequence and arrangement as at Pengaron has been proved.[3]

The sandstone-beds (stage *a* Eocene of Verbeek) can be recognised by their petrographical character, by their containing seams of black coal, called brown coal by Schwaner, and by the presence of intrusions of andesite.[4]

---

[1] Our information is derived from Horner, Schwaner, Von Gaffron, and, more recently, from Martin and Posewitz.

[2] Jb. 1882, II., 273.

[3] Posewitz, p. 43.

[4] The andesites as such were not recognised either by Horner or by Schwaner The latter made no distinctions between the eruptive rocks. They were cheifly mentioned as "dioritic rocks." Von Gaffron, however, marks them as "Gesteine der Basaltgruppe" in the Kapuas R. (Jaarboek v/h, Mynwezen 1882, II.)

The marl-stage (stage β Eocene of Verbeek) is not easily recognisable, for which reason there is no positive evidence of its occurrence, although it is certainly present.

The limestone-stage (stage γ Eocene of Verbeek) is so characteristically developed that it can be immediately recognised even from descriptions. The same resemblance exists in geotectonic relations; the higher hill-ranges belong to the Eocene, while the lower are probably late Tertiary. It is the latter which contain the coal-seams.

SANDSTONE-STAGE.

Barito and Kapuas Basin.

The Tertiary hill-land extends along the borders of the Pramassan Amandit and Alai mountains. North of Barabei the coal-bearing sandstone-beds are faulted.[1]

"The Tertiary hill-formation, a ferruginous sandstone-formation is largely developed in the basins of the rivers Pattai and Karau, in the district Duson Timor. First, there are low ranges of hills (late-Tertiary); towards the east these become higher, often reaching a height of 1,000 feet, and dividing these basins from the eastward-flowing Tabalong river, which belongs to the Barito basin. Nodules of clay-ironstone are also found in these beds. (Eocene ?)[2]

Late-Tertiary strata also seem to be widely distributed, for beds of brown coal showing similar geological relations, occur in many of the brooks. These are overlaid by a sandy clay, three feet thick, and a bed of quartz-pebbles 5-6 feet thick, (Diluvium) containing gold. The coal-seam is only four inches thick, and occurs in violet shales, with leaf impressions. The coal itself contains much resin, and is underlaid by a layer of carbonaceous shale, resting on a greyish under-clay of unknown thickness.[3] All the beds strike to the south-west, and have a dip of from 15° to 20°.

---

[1] According to communication of Grabowsky.

[2] Schwaner, S. 16, I. p. 91 & 95. [3] Ib. I. p. 25.

In the districts Duson Ilir and Ulu,[1] the "hill-formation" consists of sandstones alternating with shales, and in several places with seams of brown-coal and clay-ironstone. The coal-seams, which occur mostly in gently sloping hills, are of similar composition, and seldom show woody structure. (Eocene ?). These strata are here and there broken through by dioritic and porphyritic intrusions.[2] Above them follow dark-green and thinly laminated shales of similar thickness. (Miocene ?)

The hill-land of the north, in the districts Siang-Murong, consists of soft yellow sandstones, alternating with parti-coloured shales. The fine-grained ferruginous sandstones are like those at Pengaron, and contain small flakes of a silvery-white mica and leaf-impressions. Their bedding is very irregular, and shows sure signs of great disturbances and powerful eruptions. The beds often contain seams of brown coal.

The sandstone and limestone beds in the Sungei Bumban are traversed by dykes of green "augite-porphyry" and "grey trachyte," with small glassy felspar crystals They form small riams (cataracts).[3] Trachytic conglomerates and breccias, slaggy rocks, etc., occur frequently on the southern border[4] (these are probably andesites). The strike is mainly north and south, with deviations towards the east and west, changing about twenty times.

The first hill-ranges (late Tertiary) begin on the Kapuas[5] river above the mouth of the Kawattan, 1° 20′ south lat. The strike is north-east and south-west.

Seams of brown coal, up to twenty-three inches in thickness, occur under the gravel (Diluvium) in the river-valleys, and are underlaid by a plastic clay which itself rests on a grey, fissured limestone (stage γ Eocene of Verbeek).

Further up-stream the "sandstone-formation" (Eocene ?)

---

[1] Schwaner, S. 16, I. p. 91 & 95.
[2] Probably andesites.
[3] Horner S. 2.
[4] Jb. 1882, II. 288.
[5] Schwaner, S. 16, I. p. 23 & 24.

forms steep banks, and is broken through in many places by masses of diorite,[1] weathering into columnar and spheroidal forms. This rock has produced great disturbances in the formation; limestone, sandstone, and diorite, often following one another in rapid succession. Dioritic rocks, sandstones, and shales also occur on the bank of the tributary Sirat.

The hills, Bantan and Bahai, which are the first elevations that show themselves on the river Barito, consist of late-Tertiary strata.

They are composed of beds of a fine white quartz-sand, alternating with whitish-grey clay (weathered shale ?), in which occur seams of brown coal, showing woody structure.[2]

Basin of the Kahajan and Katingan.[3]

Schwaner travelled through the Tertiary hill-land which extends in a direction north-east to south-west from the Kapuas river, as far as the Katingan (0° 50′ to 1° 30′ south lat.). The land consists of hills, among which are some that attain a great elevation (Bukit-Ambon, 700′, Bukit Riwut, 1200′).

Towards the Kapuas the hills become higher, but towards the west they decrease in height. Similarly they invariably become higher towards the mountains, and lower towards the plains. Between these hills there are Diluvial gold-bearing plains and marshes, from which many of the brooks take their source.

The hill-land begins invariably with low hills which extend north-east and south-west. In the river-channels seams of brown coal are to be seen under the Diluvial sheet of gravel, often crossing a river; thus near Kotta Bukit, in the river Rungan, near Tumbang Danau-paken, in the river Sungei Menohing, near Penta Tapang on the Katingan,

---

[1] Probably andesites. [2] Schwaner S. 16, I. 26.

[3] Schwaner S. 16, Borneo, II. p. 32, 56, 65, 86, 88, 95, 96, 116.

near Passa Tegara on the Kahajan, and near Tandjong Bukit Buking, on the same river. Here they form the first riam met with on coming from the south (late-Tertiary ?). The high hills near the mountain-border, which consist of ferruginous sandstones, are to be regarded as Eocene.

These sandstones sometimes become conglomeratic by an increase in the size of the constituent grains (Tumbang Menjanang on the Kahajan). Eocene beds of great thickness also occur here (Bereng-Kasintu on the Kahajan, and Sungei Menohing, where they are highly inclined).

Intrusions of andesite are also found here. Mount Pohon Batu, on the Kahajan, consists, as do all the other neighbouring hills, of a "trachyte-like porphyry of a pearl-grey colour." In the Tertiary a "syenite" (andesite ?) forms a water-fall between the rivers Kahajan and Rungan in the Sungei Tahojan; and the highly inclined coal-beds in the river Menohing are probably due to the intrusions of andesite.

Basin of the Western Streams in the South of Borneo.[1]

In some places the Tertiary deposits extend to the coast. Low hills stretch from Cape Pangudjan to Cape Silaka, enclosing beds of brown-coal and gypsum (Miocene), and, farther to the north "pitch-coal" is found (Eocene).

The same beds extend from Cape Kalap to Pandaran, along the river Pembuang. Higher up, Eocene (with black coal) is developed, as in the northern basin of the rivers Sampit (Mentaja) and Kalong. Fragments of coal of the same character as the Pengaron coal, which were found in the middle river course, are an indication of this. Eocene (black coal) is also present on the upper Kantingan river, and on its tributary the Samba.

The northern boundary of the Tertiary (sandstone-stage)

[1] Von Gaffron, S. 27.

against the mountain-formation, is clearly given by the presence of coal, which extends from Cape Sampar (according to Von Gaffron), with a north-east strike.

In the south-western mountain-land, however, there are only isolated Tertiary basins; e.g., to the north-east of Mt. Lantjau, where late Tertiary eruptive rocks have broken through the strata. (Rivers Kaleh and Mungul.) In consequence of this the mountain-islands are developed here in great abundance; but they are always surrounded by Tertiary hill-land.

The occurrence of coal in this *massif* is not mentioned; but investigation in that direction has been only superficial.

Younger eruptive rocks have been intruded into the sedimentary beds at some places (River Kuhin, Mungul, and Kaleh belonging to the river Pembuang).

The Miocene beds, which form a low hill-land, and are often associated with brown coal and gypsum, extend in places to the sea-coast, and strike in an east-north-east direction from Cape Sambar, below Assem-Kumbang, on the river Katingan, towards the hill Rantau on the Barito.

Miocene beds with layers of recent brown-coal also occur on the river Sampit, below the mouth of the Kwajan. The hills strike north-north-east.[1]

MARL-STAGE.

We have no positive evidence with regard to the distribution of the marl-stage, as it possesses no striking characteristics. But it is certainly developed in many places. According to Horner[2] limestone occurs *in situ* near Lontuntur on the Barito, in alternation with black marls; and on the S. Soko (District Siang) Henrici found black marly slates with iron pyrites and pieces of red jaspar.

Up to the present we only know that it occurs on the river

---

[1] Michielsen, S. 46. [2] Horner S. II.

Teweh, and forms a part of the hill Batu Bangka on the river Barito. The specimens which were collected by Müller on his journey up the river Teweh, were described and examined by Martin:[1] two of them indicate the marl-stage,—namely, a "sandy, marly, strongly ferruginous sandstone," containing numerous fragments of Orbitoides (*in situ* above Taidjok on the Teweh), and a blackish-grey crypto-crystalline marly limestone, full of Orbitoides, with a few other foraminifera and calcareous algæ—Lithothamnium (*in situ* near Siang Naga, and above Taidjok, on the river Teweh).

The strata near the hill Batu Bangka, an isolated cliff on the left bank of the Barito, opposite Pendreh, were submitted to a close examination by Posewitz,[2] who showed that there was here an arrangement of the marl and limestone-stages similar to that at Pengaron. A light grey bed of marl-slate (fifteen inches thick), is interbedded with a marly shale and a bed of marly limestone, fifteen metres thick. Then follow two beds of marly limestone, eleven to fifteen metres thick, separated by a bed of marl-slate, one to seven metres thick. The marly limestone contains abundant fossils. The highest member of the series is a thickly-bedded limestone, about forty metres thick, containing corals.

LIMESTONE-STAGE.

The well-characterised limestone-stage is widely distributed. Even Schwaner[3] had recognised that they should be regarded as coral-reefs. "The limestones possess the undoubted characteristics of a littoral formation; they consist of enormous coral-aggregates and masses of broken shells, intermingled with the spines of echinoderms, and, resting on a bed of rock, follow the borders of the high-land, accompanying it everywhere, even into the deep inlets and round the prominent points."

[1] Martin B. 39, p. 287. [2] Posewitz S. 49. [3] Schwaner S. 16, I. p. 25-27.

A further characteristic is that the caves in the limestone contain nests of the "Hirundo esculenta," which are much sought after as an article of trade.[1] Consequently where the occurrence of these birds' nests is spoken of, the existence of this limestone may be inferred.[2]

A beautiful view of the coral-reefs is obtained from Negara during high water. As far as the eye could reach I saw, stretching out like a sea before me, marshy lowlands which apparently extend to the foot of the chain of the Pramassan Amandit and Alai mountains; and along these mountains there was a series of limestone rocks, which seemed to be washed by the waves. One could easily imagine oneself back in the beginning of the Diluvial period, and thus obtain an exact picture of the Borneo of those times.

Also from Barabei (from Pagat), I had a beautiful view of the coral-reefs, following the foot of the mountains.

The "coral-formation" extends to the north of Pengaron, where we have already studied it, along the border of the mountain-land into the central part of Borneo.

To the north of Pengaron there are the limestone rocks with many caves, which were visited by Grabowsky: the two-storied grotto of Gunong Lampinit;[3] the grotto of G. Talikor, through which an underground brook flows; the grotto of the Batu laki and bini, at the foot of which are warm sulphur-springs.[4] At the foot of the mountains Pramassan Amandit and Alai, I saw them myself; and on a limestone hill near Pagat, near Barabei, I found corals.

Near the river Tabalong Kanan, on the western border of the Krumei mountains (bounding Passir), Von Dewall also found limestones (*e.g.*, that of the Batu-hadjie). Limestones occur in the District Dusson Timor in the upper basin of the

---

[1] Daly N. 51, p. 2.

[2] It appears in S. Borneo to be of Tertiary age, while in the north and north-east of the island older limestones (Carboniferous) occur.

[3] Indian Gids, 1884, January.

[4] Weddik E. 3.

rivers Pattai and Karan, and at other places in the eastern basin of the river Barito: as may be inferred from the fact that birds' nests have been collected there.[1] Limestone rocks also occur on the Sungei Ajo; I saw this fossiliferous limestone at Buntok, where it is used as millstone.[2]

Müller was the first to describe the occurrence of limestone rocks in S. Teweh; he was followed by Schwaner, and their collections were examined by Martin. Limestone was also brought to me from the upper course of this river, during my stay in Muara Teweh. Limestone-formation predominates generally here, and the edible birds' nests of the Gunong Anga, Toko, Djokon, and Tangor, form an important article of trade.[3]

The limestone formation also extends along the northern rivers Lahay, Lauung (the latter springing from the limestone mountain G. Tangor)[3] and Bumba (where the limestones are broken through by a greenish augite-porphyry.[4] In the District Siang there are also some "birds'-nest-cliffs."[5]

Coral-limestones are also found in the neighbourhood of the mountain-island G. Pararwen. In the hills of the higher-lying lands of the rivers Limu and Pendre, many birds' nests were found in former years.[6] Limestone is found abundantly in boulders in the Barito above the S. Montallat.[7] Posewitz[8] described the Batu Bangka, an isolated limestone-rock on the left bank of the Barito opposite Pendre; and Horner,[9] mentions one a little farther from mount Tubang[10] on the right

[1] Schwaner S. 16, I. p. 24, 95, 97.
[2] Ib. S. 16, I. p. 108.
[3] Ib. S. 16, I. p. 119.
[4] Horner S. 2.
[5] Schwaner S. 16, II. p. 127.
[6] Ib. I. p. 114. F. S. Hartmann had already mentioned the Limestone Birds'-nest Cliffs in the upper course of the R. Teweh, from Sungei Montallat, Aju, Limu. See S. 34.
[7] Schwaner I. p. 108.
[8] Posewitz S. 49.
[9] Horner S. 2.
[10] Mount Tungan, as stated by Martin; Jb. v/h. M. 1882, II. 288.

bank of the Barito opposite the deserted village of Lon-tuntur: the stratigraphy of both the last-named places is well-known.

The limestone stage is also present on the river Kapuas.[1] Above Batu Tampong the limestone-formation predominates. It underlies a bed, ten to twelve feet thick, of a grey plastic clay. The limestone is greyish-white, and not well bedded. In many places it contains spheroidal chalcedony and flints. Fossilised corals are of frequent occurrence in this limestone.

The limestone-stage is continued into the western river-basins. In the upper basin of the Kottaringin, in its tributaries the Arut, the Lamandan, the Plantikan (mount Batu hadjie, Menunting), and in the basin of the Sampit, Von Gaffron[2] mentions the occurrence of "Muschelkalk,"[3] by which our coral-reefs are meant. They extend as far as the coast where Nummulite-bearing limestones have been proved by Van Dyk.[4]

Only in the basins of the Kahajan and Katingan is their occurrence not mentioned by Schwaner.

In summarizing the distribution of the coral-reefs in South Borneo, we find that they sweep round the western border of the south-eastern mountain-land of Tanah-Laut; further, that they occur near the G. Pararawen and on the river Kapuas, also in western S. Borneo, in the middle parts of the mountain-land (G. Batu-hadjie).

On nearer investigation the gaps still existing will probably be filled up; it is possible that the limestone-band extends in a north-north-east direction from Sampit on the upper Kapuas, to G. Pararawen on the Barito, parallel to the strike of the coal-bearing strata?

Useful Minerals in the "Hill-land."

Coal.—This is of wide occurrence in the sandstone beds

[1] S. 15, p. 150.
[2] S. 27.
[3] Van Dyk B. 13, p. 145-149.
[4] See Horner on this (Historical Part).

(stage *a* of Verbeek's Eocene), being the so-called Indian "pitch-coal," or black-coal; while seams of brown-coal occur in several places in the Miocene. (See *Coal*).

Clay-iron-stone occurs abundantly as layers of concretions between the shales. (See *Iron-ores*).

Age of the Tertiary "Hill-land."

Horner and Müller, the first scientific travellers in South Borneo, put the coal-bearing sandstones in the "Secondary formation," and referred it to the Jurassic,[1] from analogy with similar rocks on the island Timor, thus following Leonhard, who gave them the same age.[2]

Schwaner was the first to call this formation Tertiary, and to recognize Nummulites in the limestones of Riam Kiwa.[3]

The first two collections of fossils from S. Borneo (one by Motley,[4] the Director of the Julia-Hermina coal mine, near Kalangan, and sent to Bleekrode in Holland, and a second from the river Riam Kiwa, partly from Banju-irang, also sent to Holland) served for the determination of the beds, but were afterwards lost.[5]

The fossils were the following[6]:—

1. (*a*) FROM THE RIAM KIWA:—

Nummulina depressa.	Phaculina Faujasii,
,, tenticularis,	Flabellum sp.
,, mamilla,	Phyllocœnia sp.
,, polygyrata,	Astrocenia sp.

(*b*) FROM BANJU-IRANG:—

Eupatagus ornatus,	Phyllocœnia sp. and other undetermined species of Polyps.
Nummulina depressa,	

[1] Horner S. 2, and Jb. v/h M. 1882, I. p. 152, and 1882, II. p. 292.

[2] There is, however, a contradiction in Horner's work. In mentioning the coal-formations he remarks that there are two, but neither older than Tertiary.

[3] Schwaner S. 21; Verbeek S. 41, p. 22; ib. S. 40, p. 141.

[4] J. Motly was at first director of the coal mines in Labuan (see his work on the coals of Labuan, W. 7). In the fifties he came to Kalangan, where he was murdered in 1859 during the insurrection.

[5] Kloos B. 20.

[6] Bleekrode B. 16; Kloos B. 20.

2. From Kalanoan (Motley's Collection):—

Operculina plicata,	Spatangus depressus,
Fusulina,	Ostrea,
Nanionina,	Cardium,
Rotalia,	Pecten,
Dentalium elephantinum,	Fish-teeth; leaves of Laurels and Myrtles; piece of the stem of a Cycad.
Cancer Desmaresti,	
Belemnites,	

According to Kloos the age is "Chalk and older Tertiary," since some of the fossils of these two collections, *e.g.*, Cancer Desmaresti and Phaculina Faujasii, are, according to him, Senonian types. On the other hand a collection made by H. Staring (1863) in the shales lying between the coal-seams in the Riam Kiwa, contained fresh-water shells which, show a great resemblance to living Unios and Cyrenas, and point to the coal being of very recent date.[1]

In South Borneo the mining-engineer C. de Groot[2] mentioned (in the fifties) some nummulites which he found in some places in the limestones of the Riam Kiwa; while in West Borneo Everwyn[3] was the first to describe the occurrence of fossils in Tertiary strata.

In the fifties also the determination of the age of the Tertiary was made on palæontological grounds.

P. Van Dyk[4] was the first to examine (in 1858) the fossils in Batavia, in order to establish the age of the coal-beds in Borneo. He placed them in D'Orbigny's stage—"Suessonian,"—and showed, by a determination of the fossils found by Everwyn in the coal-bearing strata (*e.g.*, Melania inquinata), that the coal did not belong to an older horizon.

Van Dyk also was the first to show that the coal in South and in West Borneo was of the same age. He distinguished four species of Nummulites.

In the beginning of the seventies Verbeek undertook the

---

[1] Kloos B. 20, p. 302.
[2] S. 23, im. n. T. v. N. I. p. 40-49.
[3] W. 39.
[4] B. 13.

determination and figuring of the nummulites from the river Riam Kiwa.[1]

According to him they belong to four different species, among which two are new, the third is a known species, and the fourth, a new variety of a species already known. They comprise :—

1. Nummulites Pengaronensis, Verb. of rare occurrence, with many Orbitoides (O. discus, Rüt.) in a limestone of stage β. This is the lowest horizon in which nummulites occur.

2. Nummulites sub-Brongniarti, Verb. occurring in stage γ, together with the next following two species, and many other fossils.

3. Nummulites Biaritzensis, d' Arch.

4. Nummulites striata, d'Orb. Var., both species occurring also in stage γ, in which stage there are also Orbitoides.[2]

Detailed palæontological investigations were made (in the seventies) on fossils collected by Verbeek in South Borneo on the river Kanan, by the well-known palæoneologists Dr. O. Böttger, Dr. B. Geyler, and Dr. C. Von Fritsch,[3] which resulted in these strata being assigned to the Eocene.

Verbeek's collections contained the following fossils (arranged according to classes and beds) :—

1. GASTEROPODA.

STAGE α (VERBEEK), (SANDSTONE-BEDS) :—

Conus gracilispira n. sp.	Mitra æquiplicata n. sp.

STAGE β (VERBEEK), (MARL-BEDS) :—

Turbo borneensis Böttg.	Conus gracilispira n. sp.
Turbo paucicingulatus n. sp.	Voluta Barrandei Desh.
Natica sigaretina Lmk. sp.	Mitra æquiplicata.
Terebra bifilifera n. sp.	

[1] Verbeek S. 40. [2] S. 40, p. 159. [3] B. 32, 35, 36.

STAGE γ (VERBEEK), (LIMESTONE-BEDS):—

Cerithium filocinctum n. sp.
Turbo borneensis Böttg.
Natica patulæformis n. sp.
Natica Flemingi d'Arch.
Natica spirata Lmk. sp.
Rimella inæquicostata n. sp.
Buccinum? pengaronense n. s.p.
Cypræa angygyra n. s.p.
Cypræa paniculus n. s.p.

2. LAMELLIBRANCHIATA.

STAGE α (VERBEEK):—

Tellina biornata n. sp.
Teredo striolatus n. sp.
Corbula Lamarckii Desh.
Cytherea? suessoniensis Desh.
Cyrena pengaronensis n. sp.
Cyrena borneensis n. sp.
Cypricardia tenuis n. sp.
Cardium eduliforme n. sp.
Cardita borneensis n. sp.
Nucula Studeri d'Arch.
Arca lucinæformis n. sp.

STAGE β (VERBEEK):—

Psammosolen truncatus n. sp.
Siliqua annulifera n. sp.
Panopæa filifera n. sp.
Anatina annulifera n. sp.
Tellina rotundata n. sp.
Tellina donacialis n. sp.
Cytherea Herberti Desh.
Venus sulcifera n. sp.
Cypricardia? sulcosa n. sp.
Cardium subfragile n. sp.
,, anomalum Math.
,, limæforme d'Arch.
Lucina borneensis n. sp.
Cardita arcæformis n. sp.
Arca hybrida Sow.

STAGE γ (VERBEEK):—

Teredina annulata n. sp.
Sunetta sinuosa n. s.p.
Cardium deplanatum n. sp.
,, subfragile n. sp.
,, anomalum n. sp.
,, limæformæ n. sp.
Corbis minor n. sp.
Lucina corbulæformis n. sp.
Arca hybrida Sow.
Avicula peregrina n. sp.
Lima? sp.
Pecten Favrei d'Arch.
,, rete n. sp.
,, Hopkinsi d'Arch.
,, Bouéi d'Arch.
,, subarcuatum n. sp.
Spondylus rarispina Desh.
Ostrea Archiaci Bell.
Ostrea! rarilamella Desh.

3. BRACHIOPODA.

STAGE β:—

Terebratula pengaronensis n. sp.

4. ECHINODERMATA.

STAGE γ:—

Cidaris acanthica n. sp.
,, Janus n. sp.
,, longicollis n. sp.
Clypeaster phyllodes n. sp.
Echinolampas dispar n. sp.
Verbeekia dubia n. g. n. sp.

5. CORALS.

STAGE γ:—

Heliopora Böttgeri n. sp.
Smilotrochus? brevis n. sp.
Stylophora cf. italica d'Arch.
Trochosmilia? discoides n. sp.
Stephanosmilia? humilis n. sp.
Holocœnia stellata n. sp.
Leptophyllia sp.
Montlivaltia sp.
Ceratophyllia n. g.
,, flabelloides n. sp.
,, hippuritiformis n. sp.
Dasyphyllia?
Heliastræa? Verbeekiana n. sp.
Solenastræa oligophylla n. sp.
Astrocœnia foliacea n. sp.
,, immersa n. sp.
Latimæandra discus n. sp.
Cylicia?
Astrangia? folium n. sp.
Rhizangia agglomerata n. sp.
Lophoseris hospes n. sp.
Madrepora lavandulina Michel.
Dendracis Geyleri n. sp.
Actinacis digitata u. sp.
Polyaræa gemmans n. sp.
Dictyaria elegans Leym. sp.

6. BRYOZOA, ANNELIDA, CRUSTACEA.

7. FORAMINIFERA.

Nummulites pengaronensis Verheek. (Stage β.)
,, sub-Brongniarti ,, (Stage γ.)
,, striata d'Orbigny ,, (Stage γ.)
,, biarritzensis d'Arch. ,, (Stage γ.)
Orbitoides papyracea Boubée. (Stage β)
,, ephippium Schl. ,,
,, dispansa J. de Sow. ,,
,, decipiens n. sp. ,,
,, omphalus n. sp. ,,

8. PLANTS.

Phyllites (Ficus) Pengaronensis.
,, (Artocarpus) Verbeekianus n. sp.
Litaea Böttgeri n. sp.
Phyllites (Grumelia) mephitidioites n. sp.
,, (Tabernaemontana)? sp.
,, (Locanthus) deliquescens n. sp.
Etoneuron melastomaceum n. sp.
Phyllites (Sterculia?) sp.
,, (Pterospermum) gracilis.
Carpites (Dipterocarpus) Pengaronensis.
Phyllites (Hopeæ præcursor).
Nephelium Verbeekianum.
Leguminosites (Albinia) sp.

"The condition of the fossils was unfortunately unsatisfactory, as the remains were neither numerous nor well-preserved. Under these circumstances their determination could not obtain the accuracy to be derived from a more complete series of specimens.[1] On this account the new species are not to be compared with those of the Tertiary basins of Paris, Vienna, or Mayence. Similarly the greater number of the plant remains are badly preserved.

With regard to the fossil Molluscs, Böttger says:—

"The eighteen species of Gasteropods which admit of certain determination are all inhabitants of the sea. They are the genera Cerithium, Turbo, Natica, Buccinum (?), Terebra, Conus, Rimella, Mitra, Voluta, and Cypræa—a mixture of Gasteropods that gives no clear idea of the then existing sea. Yet they have the character of a tropical fauna, and the presence of Rimella, Voluta, and Ampullina, gives the plainest indication that these are Eocene deposits. On the other hand it should be noted that the majority of the species, as far as they can be compared with living representatives, have their nearest allies in the fauna of the East-Indian islands.

Of the genus Cerithium, which in regard to species and number of individuals reaches a maximum in the Eocene, there were only two very badly-preserved forms.

The genus Turbo, generally well developed in the Eocene, was only represented by a few unimportant species.

Only five species of the genus Natica could be distinguished with certainty, of which one, owing to imperfect preservation, must remain doubtful.

Of the Strombidæ, a family very characteristic of the Eocene, only a single species of Rimella is known up to the present.

The family of the Muricidæ, which in the Eocene is usually characterised by a great abundance of forms, plays only a subordinate *role*, being represented by the genera Terebra and Buccinum (?)

Of the Conidæ there is only the genus Conus, while Pleurotoma—so richly represented in the Tertiary of Europe—is here absent.

---

[1] B. 32, p. 12–13; B. 35, p. 127; B. 36, p. 21.

The Volutaceæ are only represented by the genera Voluta and Mitra; the family of the Cypraeaceæ by the genus Cypraea.

The class of the Lammellibranchs is much better represented than that of the Gasteropods. There is a rich abundance of characteristic marine forms, but in the lowest stage there is also a fresh-water type. As in the case of the Gasteropods we have here representatives both of the coasts and of the deep sea.

There are two representatives of the family of the Pholadidæ,—viz., Teredo and Teredina (the latter genus being, as far as is at present known, exclusively confined to the Eocene.

The Solenidæ are represented by the genera Psammosolen and Siliqua; the Glycimeridæ by Panopaea.

The family of the Myacea is represented by the genus Corbula; the Anatinidæ by the genus Anatina.

Of the Tellinidæ, which are much developed in present tropical seas, there is only the genus Tellina; of the Conchæ, the genera Cytherea, Sunetta, and Venus (?)

The family of the Cycladea is only represented by the genus Cyrena, which in the clearest way shows that fresh-water co-operated in the deposition of the coal-beds in Borneo. Of the three species of this genus, two occur frequently in the shales (Letten) which enclose the coal, and are to be regarded as characteristic fossils.

These are Cyrena pengaronensis (n. sp.), and Cyrena (Cyprina) boneensis, Verbeek.

The Cardiaceæ are represented by the genera Cypricardia and Cardium (?); the Lucinaceæ by Corbis and Lucina; the Astarteæ by Cardita; and the Nuculaceæ only by Nucula. The Arcaceæ are represented by remarkably few genera and species, only the genus Arca; the Aviculaceæ by Avicula (?); the Pectinaceæ by a doubtful species of the genus Lima, by Spondylus, and by numerous forms of the genus Pecten; the family Ostreaceæ by badly-preserved forms of Ostrea.

There is only one representative of the Brachiopods—Terebratula pengaronensis, which, however, possesses considerable interest, because it indicates the presence of a deep sea, at that period, in Borneo (for this class of animals chiefly inhabits deep seas).

The few species of Echini do not suffice, according to Von Fritsch,[1] for the determination of the age of stage γ in which they are found. No characteristic form of Eocene or Oligocene formations could be determined by which a comparison might have been made. The Echinolampas is a form which gives very little information with regard to the age of the beds. The comparatively numerous Cidarides could be regarded as an indication of greater age, but the Clypeaster species have their representatives chiefly in more recent Tertiary formations, and the Spatangoids, present in these beds, must certainly be regarded as of a more recent type.

Of the fossil corals which, for the most part, are well-preserved, only Aporosa and Perforata are represented.[2] The Turbinolids are represented by the rather-doubtful Smilotrochus brevis. The Stylo-phorinae have a representative in the Stylophora italica, d'Arch. The Astraeidæ are present in comparative abundance in the two groups of the Eusmilines and Astraeines. Among the Perforata the Madreporidae are represented by a Madreporina and two Turbinarinae; and the Poritidæ by two species of the Gonioporaceæ.

Von Fritsch say further:—"The well-known coral-fauna of the Nummulite beds of Borneo consists, therefore, of the remains of twenty-six species, of which five could not be named.[3]

Of the twenty-one remaining species, I am obliged to furnish eighteen with new names, and only in three cases did I

---

[1] B. 35, p. 142. [2] Ib. 35. [3] Ib. p. 227.

feel myself justified in applying names which have been used for the corals of the Lower Tertiary formations of S. Europe. Twelve of the twenty-one species are peculiar to the Eocene of Borneo, and even with regard to the three above mentioned forms, it is doubtful whether they ought not to be regarded as independent species. We have thus a coral-fauna consisting entirely of new species."

The corals of Borneo belong to the reef-corals, and future collecting will not be likely to produce deep-sea forms. With regard to the Bryozoa there is no exact information available. They invest the surface of the corals. Also with regard to the Annelides, which were frequently observed, a determination of the species could not be carried out; and the Crustacean remains were in a bad state of preservation.

In stage β Von Fritsch examined the abundantly-occurring Orbitoides which are associated with Nummulites pengaronensis, and recognised five species, of which three were already known, but two were new.

The plant-remains[1] were so badly preserved, that only a few could be referred, with any certainty, to distinct genera; the greater number, however, were designated as Phyllites, the probable generic name being put in brackets. The determination of the age of the plant-beds (Eocene stage *a* of Verbeek) is only preliminary, according to Geyler.

This small Borneo-flora has a purely Indian character, and it shows a great resemblance to types now living on the Sunda Islands, and points to climatic conditions similar to those existing at the present time in those districts.

The position of the beds under true Nummulitic limestone is, however, indicative of an Eocene age, and again, there is a slight resemblance to the flora of the Chalk. Geyler says:—"While the resemblance to types still living prevents our

[1] Hochstetter (B. 10, p. 288) mentions that C. de Groot sent plant-remains to Göppert, in Breslau, for determination as early as the fifties, nothing, however, has been published on them. Dr. Th. H. Geyler, B. 36.

placing this formation in the Cretaceous period, Verbeek's work shows that it cannot be placed among formations younger than the Eocene; although its near resemblance to living types appears to justify this course. Consequently we arrive at these preliminary conclusions:—

1. "The flora of the pitch-coal of Pengaron in Borneo is, on account of its resemblance to present types of vegetation, to be included in the Tertiary formation, and since it is overlaid by true Nummulitic Limestone, it must be regarded as Eocene.

"2. The climate, existing at that period, resembles that existing at the present time in the Sunda Islands.

"3. The vegetation of the Sunda Islands has retained its Indian character, from the Eocene period down to the present time; although the Tertiary floras of Europe have been considerably modified."

Ettingshausen combats the idea that this flora[1] is purely Indian. While Geyler compares all the fossil-plants with species belonging to the Indian Monsoon-district, Ettingshausen[2] maintains that of Geyler's thirteen Phanerogam species, only three certainly, and two probably, are Indian forms. The remaining species cannot be compared with present types, on account of their bad state of preservation. Only in the case of one species (Phyllites precursa, Geyler), are there any grounds for believing that this species has its present analogue in the extra-tropical floral districts of Asia, belonging probably to Alnus, and corresponding with A. nepalensis.

The determination of Verbeek's three stages as Eocene has not remained uncontradicted, and Martin[3] especially has attacked it both on general and on special grounds. He urges

[1] Ettingshausen, B. 43.

[2] For details on the Tertiary flora of the Sunda Islands, see Ettingshausen B. 43, p. 373.

[3] B. 39, p. 311-331.

objections[1] even to the principles which had been followed in naming the strata. According to his opinion, the determination cannot be made on the same lines as that generally adopted for European and neighbouring deposits. One must not expect to find the same percentage of recent forms in equivalent deposits of the Tropics as in the Temperate and Arctic Zones; nor is one justified in establishing the age of tropical Tertiary deposits on the presence of organisms which occur in the corresponding deposits of extra-tropical regions; above all things, in naming Indian strata one should not depend on the occurrence of genera known to occur in the Tertiary of Temperate Zones.

"As long as no Tertiary deposits are known, which will serve to connect the tropical with the extra-tropical formations, the determination of the age of tropical Tertiary strata, must not be based on a comparison of the Fauna and Flora of known Tertiary deposits, but rather on a comparison with the animal and vegetable world now existing there."

Martin in his criticism on the Eocene formation of Borneo, shows "that the foraminifera furnish no proof of the Eocene age of the limestone (stage γ);" that the fossils which were examined constituted unfavourable material; that the determination of the species is excessively uncertain; that the species determined by Böötger indicate a late-Tertiary rather than an early Tertiary age; that the plants examined by Von Geyler have only been included in the Eocene, because they lie under the Nummulite limestone; that in the determination of the Echini and the Corals no proof of an Eocene age was to be found, as was the case also with the Crustaceans; and finally, that no proof of an Eocene age can be founded on the presence of the Orbitoides.

[1] For details see Martin. *Tertiärschichten auf Java, Algemein Theil* p. 21, and B. 45.

Martin holds that the limestones (stage γ Verbeek) are of Miocene age, because equivalent beds underlie Miocene beds in Java, and he calls them early Miocene to distinguish them from the later deposits of Java. On the other hand he con siders it probable—although not proved—that the stages α and β[1] of Verbeek are Eocene.

Martin[2] strengthens his opinion that these are Miocene beds, by an examination of the specimens collected by Horner and Schwaner on the Teweh, and not far from its mouth (near Lontuntur). In a sandy, marly, ferruginous sandstone, he finds many Orbitoides; in a marly limestone many Orbitoides, together with Nummulites and Nullipores (Lithothamnion); in a bluish-grey, finely-crystalline sandstone Nummulites, Orbitoides, fragments of Corals, and Lithothamnion Rosenbergi (?); in a white, granular, much-metamorphosed limestone, besides Orbitoides, Nummulites, etc., Astraeids and Madrepores. In a dark-green, fine grain sandstone from mount Tubang[3] many Foraminifera and Algæ, as Cycloclypens, Rotalia, Globigerina, Textularia, Lagena, Amphistaegina.

West Borneo.[4]

The Tertiary formation is also much developed in W. Borneo, the most wide-spread being the lowest or breccia-stage of Verbeek, which in the remaining parts of Borneo is, as yet, unknown.

Up to the present it is only known in the upper Sikajam basin.[5] In three places in this district masses of conglome-

[1] The age of the limestone-rocks (Batu Bangka) near Teweh, appears, according to Hantken to be upper-Eocene.

[2] Martin B. 39, p. 285-289.

[3] Not Tungang, as Martin has it, opposite to Lontuntur.

[4] For our information with regard to the basins of the Kapuas, Sukadana, and the Chinese District, we have to thank Everwyn in the fifties, and Van Schelle in the eighties (Chinese Districts); Schwaner for the little we know of the basin of the Melawi; and Von Gaffron for the geological map of the southern portion.

[5] Van Schelle W. 62, p. 126, 128, 139.

rate were found lying on gabbro. This conglomerate is composed of fragments, varying in size from a nut to a child's head, of flint, quartzite, and quartz-sandstone, united by a siliceous cement.

In some places small patches of sandstone occur. It is mostly greenish-grey, and consists of small angular, and rounded grains of quartz, occasionally with small flakes of mica. The cement is partially siliceous, partly argillaceous. The sandstone is thickly bedded; and some beds are clayey, others conglomeratic.

The sandstones lie among shales, and their pebbles, as well as boulders of the conglomerate, are often found in the Diluvium.

The age of these rocks cannot be determined, for want of fossils. They appear, however, to belong to a recent formation, possibly early Eocene, being equivalent with the breccia-stage in the highlands of Padang, in Sumatra.

Similar rocks are described by Van Schelle on the river Landak.[1] [2]

The remaining three stages are as well developed as in S. Borneo. But while the sandstone-stage is widely distributed, the marl- and limestone-stages are found only in a few places.

Tertiary in the Basin of the Kapuas.

The Tertiary formation is most developed in the district of the river Kapuas, and forms here the great Kapuas basin.

Beginning near Mount Tjempedeh, near Tagan, the hill-land extends in an easterly direction to the sources of the river Bunut, a distance of forty-five geographical miles. Its width in the lower parts is two to three geographical miles, but it attains near Sintang a width of ten geographical miles.[3]

---

[1] Van Schelle W. 62, p. 126, 128, 139.
[2] On the relation existing between these rocks and diamonds, see "Diamonds."
[3] Everwyn W. 33, p. 96.

In the upper basin of the river Kapuas the hill-land not, only forms the boundary of the Kapuas-plain, but also constitutes some isolated heights in it. Near Siutang it approaches the river from both sides, but on the west it retreats again, forming a gulf-like opening turned towards the sea. While the beds of the sandstone-stage here predominate everywhere, and chiefly compose the whole hill-land, near Spauk they dip under Miocene-deposits, which extend towards Tajan.[1] The strike of the hill-land mostly runs parallel to the boundary of the mountain-land. In the river Bojan it is south-west and north-east, the dip being 42° to 44° north-west; in the direction of the Kapuas, near the river Napan, the dip is 7½°; near G. Penei, on the Kapuas, the strike is east and west: near Telok Dah, near Sintang, north-west and south-east, dip 20° to the north-east.

But as a rule the bedding when not disturbed, is either slightly inclined or horizontal, *e.g.*, near Sintang, Salimbau, and Landak.[2]

Petrographically, the sandstone-stage is similar to the equivalent beds near Pengaron, in S. Borneo. It is characteristic for them that they almost invariably contain coal seams.

On the river Napan[3] (basin of the river Bojan, upper Kapuas), sandstones, carbonaceous shales, and coal occur. The former are white or yellowish-white, and consist of grains of quartz, with small silvery-white flakes of mica, and a siliceous and argillaceous cement. The bluish-grey shales contain imperfect leaf-impressions; the carbonaceous shales are easily cleaveable.

Tertiary in the Basin of the Melawi.

The Tertiary basin of the Melawi is almost entirely unexplored.

---

[1] Everwyn W. p. 12-44.

[2] Jaarboek v/h M. in N. J. 1884, II. p. 286.

[3] Van Schelle W. 57, p. 92.

The hill-land begins on the Tumbang Serawai. It is very remarkable that the Tertiary penetrates so far into the mountain-land. Schwaner found sandstone pebbles at the foot of the mountain-land; but in the mountains themselves, the banks of the river Mandatai are formed of granite, covered with a thick layer of shale-gravel (Laterite?); further mount Bukit Krapan consists of a white, very fine sandstone.[1] Again on Von Gaffron's map Tertiary is marked as occurring in the mountain-land of S. Borneo.

The bedding conforms to the mountain-border, and is slightly inclined towards the Melawi.

Eocene strata form the greater part of the watershed between the Kapuas and the Melawi. Thus, for instance, the mountain ridge G. Klam, near Sintang (south-west and north-east), which rises steeply to a height of several hundred feet, consists, according to Crookewit, of a recent, white, non-micaceous quartz-sandstone, with an argillaceous cement.[2] It is not known whether coral-limestones occur in this mountain-chain.

The marl-stage has not been found in the Kapuas basin;[3] on the other hand, the limestone-stage is known in a few places.

Coral limestone is only known to occur *in situ* on the river Bojan, where it has been found at three places, with badly-preserved fossils (Polyps and Encrinite-stems). It is mostly fine-grained, of a blue-grey colour, and traversed by white-calcite veins. No bedding is visible.[4]

Pebbles of coral-limestone in the Diluvium are also known in the Mentiba (Silibit),[5] a tributary of the Bunut, and the fact that a part of the mountain-ridge G. Klam also consists of it, has been already mentioned.

---

[1] Schwaner S. 16, II. p. 159-162.

[2] Dr. Crookewit, W. 24.

[3] It is true Everwyn mentions a marly limestone on the R. Seberuang (Jb. v/h. M. 1879, I. 25); but this is of Cretaceous age (see Cretaceous formation).

[4] Jb. v/h. M. 1880, II. p. 20.

[5] Ib. 1879, I. 21.

Everwyn[1] gives the following section near Sintang:—

Loose sand, 2m. Diluvium, fine-grained greenish.	
Grey-sandstone, 1·50 m. Miocene (?).	
Bluish-grey shales, 1m.	
Coal with carbonaceous shales, 0·93 m.	Eocene *a*.
Grey hard shales, 0·50 m., bluish-grey clay.	Eocene *a*.
Sandstone, 1·20 m., grey shales.	Eocene *a*.

Near Ngabong (Landak) the hill-land consists of a "clay-sandstone formation," similar to that near Sangau; it extends to Madjau.[2]

Concretions of clay-ironstone are occasionally found embedded in the shales, and also layers of concentrically laminated clay concretions similar to those I found on the river Teweh, S. Borneo.[3]

Recent Eruptive Rocks.

The strata in the Kapuas basin are also disturbed by intrusions of andesite.

Eruptive rocks are said to occur in several places, *e.g.*, the hills Depatan and Miangau, on the river Mentiba (Bunut), and the hill Sindoro, near Djonkong, on the Kapuas.

In the river Djonkong, the eruptive-rock occurs as a dyke through the coal-beds, and crosses the river; and the hill Sindoro is composed of the same porphyritic rock. There is also an eruptive rock lying between Tertiary strata on the river Mentiba; so that we are probably correct in assigning them an age similar to the remaining late eruptive-rocks of Borneo. They are probably andesites.[4]

---

[1] W. 39, p. 30.
[2] W. 39, p. 52.
[3] W. 39, p. 32.
[4] Jb. v/h. M. 1879, I, 18, 19, 22.

Tertiary in Sukadana.

The Tertiary formation is not known to occur for certain in other parts of W. Borneo, but there is every indication that it is present there.

Everwyn, however, does not consider this probable; he says,[1]—"It is not probable that this Tertiary formation occurs elsewhere in W. Borneo. This is known for certain, for all the southern states, as well as for the districts Mandor, Mampawa, the "Chinese districts," and Palo, which lie to the north of the Kapuas. But it cannot be maintained with the same certainty of the upper basin of the river Sambas, as the geology of this district is quite unknown; should coal occur there, however, it will doubtless be of no great development."

The indications in favour of the occurrence of Tertiary strata in the southern states, Sukadana, etc., are not of great value.

It must first be mentioned that the formations that occur there are not sufficiently defined. Only old eruptive masses and slate, apparently of great age, are mentioned; besides them, however, sandstones, which are occasionally conglomeratic, and shales containing clay-ironstone-conglomerates (island of Bessi) occur.

In the western parts of S. Borneo "old slates and old eruptive rocks," "diorites and granites," are, according to Von Gaffron, abundantly represented; the same is also true of the Tertiary formation.

A priori it is probable that the whole geological structure in Sukadana is similar to that in the western part of S. Borneo, and that the Tertiary formation must also be developed there.

To judge from the petrographical character of the sandstones, we have to deal with Tertiary strata.

---

[1] Everwyn W. 39, p. 96.

The siliceous sandstones must be included in the (Sandstone) stage II. Eocene, although, up to the present, coal has not been found in them. Similarly the shales containing the concretions of clay-iron-stone of the island of Bessi, belong to this stage,[1] as they do not occur in any other formation.

These rocks are included provisionally under the head of the "old slate-formation," although it appears to me more probable that they belong to the Tertiary, and chiefly to the sandstone stage. They border on the "mountain-land," as is the case in the "Chinese districts."

Nothing is known of the marl- and limestone-stages.

Tertiary in the "Chinese Districts."

The doubtful rocks, similar to those in Sukadana, that extend along the western border of the "old slate formation" of Mandor, to beyond Montrado, have already been mentioned.

That fragments of the "breccia-stage" occur along the Sarawak boundary, has also been mentioned. Eocene sandstones extend along the river Landak,[2] from Ngabong to Madjan. As already mentioned it is an "argillaceous sandstone formation," similar to that near Sangau.[3]

Nothing is known with regard to the marl-stage.

Near Siluas, on the upper Sambas river, limestone[4] beds occur, forming an isolated series (5–6 m.) lying on shales.

The compact bluish limestone traversed by white veins, shows no stratification, and resembles the limestone near Betung on the Kapuas.[4]

Fossils have not yet been found in them. Van Schelle holds them for coral reefs (Tertiary? Carboniferous limestone?).

---

[1] Everwyn W. 39, p. 58-77, and Jb. v/h. M. 1880, II. p. 7, with ten maps belonging to them.

[2] Van Schelle, W. 62, p. 139.

[3] Everwyn W. 39, p. 52.

[4] Jb. 1885, II. p. 91.

Eruptive Rocks.

Eruptive rocks are mentioned in several places in the "Chinese districts"; namely, basalts, andesites and rocks that are stated to be hornblende-andesites, or "diorite-porphyries."

In the absence of positive evidence with regard to the Tertiary strata, the age of these rocks is difficult to determine.

According to Van Schelle,[1] younger eruptive rocks, basalts, and andesites, occur in the neighbourhood of the Bajang mountains; of these the basalts are of more recent age than the andesites. They lie directly on the old slate-formation. The basalts form an extended table-land; the andesites occur in steep mountain ridges, or as streams which have flowed from more or less well-preserved craters.

In the upper basin of the Sikajam, eruptive masses occur in several places, as dykes, which, according to Van Schelle, are hornblende-andesites or "diorite-porphyries."[2]

In only one place (Siluas) is an eruptive dyke known to traverse the sandstones (Tertiary ?).

Determination of the Age.

The age of the sandstone-stage, together with its coal, was determined to be Eocene, *i.e.*, of the same age as the the coal-bearing strata near Pengaron, in S. Borneo. The same fossils were found by Everwyn (in 1856 and 1857) near Telok-Dah, above Sintang (the first that has been found in West Borneo on the Kapuas); further, near the mouth of the river Tampunah and in the Klinau, a tributary of the river Spauk; in two places on the river Melawi, in the neighbourhood of Sintang, and above Pinoh. They were determined by P. van Dyk. According to Van Dyk, the fossils, Cyrena cuniformis, Melania inquinata, and a Congeria, prove that we have here

[1] Van Schelle W. 74, and Java Verslag, 1887, I. and II.
[2] Ib. W. 62, p. 128-132.

to do with Eocene beds (stage Suessonion of D'Orbigny). Van Dyk was also the first to point out the identity in age of the corresponding strata in W. and S. Borneo.

There is further a petrographical resemblance between the sandstone-stages in S. and W. Borneo.

Useful Minerals.

Coal and clay-ironstones.

Late-Tertiary Strata.

In the basin of the Kapuas[1] they occur here and there between the Eocene beds, chiefly, however, below Spauk, where they overlie the Eocene beds. In the neighbourhood of Tajan they are covered by Alluvium.

In the basin of the Melawi no details are known with regard to the late Tertiary strata. Probably the greater number of the sandstone and shale beds underlying the gold-bearing gravel, belong to this formation. Late Tertiary strata are not mentioned in the remaining districts of western Borneo.

Petrographically there is some resemblance to the late Tertiary strata of Pengaron, which are probably of the same age. Greenish grey clayey sandstones (marl) form the lower horizon, and alternate with dark-brown, sandy, and clayey beds, while they pass upwards into a yellow, sandy clay (banks of the river Sanggau).

In the hill-range Lawan-Kari there occurs a greenish gray clayey sandstone (marl) containing a little lime, with larger quartz pebbles, and dark-brown clayey boulders united by a calcareous cement.

The bedding is always horizontal.

The age could not be determined on account of the absence of fossils.

Of useful minerals the beds contain brown coal.

---

[1] Everwyn W. 39, p. 12-44.

East Borneo.[1]

The "hill-land" has a wide-spread occurrence in the States of E. Borneo; it borders the mountains, and in places approaches the coast. As far as our present knowledge goes (which, however, is rather deficient), it is composed here of the same strata, partly of Eocene, partly Miocene age.

Geotectonically it is a hill-land of some hundred feet height (Eocene), in which the hills form low ranges (Miocene).

The different groups of strata are recognisable by their characteristic peculiarities. The coal-bearing sandstone beds belong to stage *a*, Eocene (Verbeek); they are here also disturbed by intrusions of andesite. The limestones are easily recognised as such, and are to be regarded as coral-reefs, while the brown-coal-bearing beds belong to the Miocene when they underlie the Diluvial gravel.

The distribution is extensive. The Tertiary "hill-land" borders the "mountain-land," extending from the south-east point of the island to Bulongan, in places reaching the coast, and probably also forming a large Tertiary basin on the river Mahakkam in Kutei.

According to the latest researches of Hooze, the Eocene formation (stage *a*) is only known in the southern parts of East Borneo. Here it is found in the north-western parts of the islands of Laut and Sebuku, being continued over the island Suwangi, the islands of Nangka, Tandjong Dewa, Tandjong Batu, to the bay of Klumpang and Pamukan (Kusan and Tanah Bumbu). Probably it is continued further to the north in the interior of Passir. On the coast further to the north, only Miocene strata are found,

[1] For our knowledge with regard to Pula Laut, we have to thank the mining-Engineers, C. de Groot and Hooze; with regard to Kusan, Tanah Bumba, and Passir, Von Dewall chiefly, also Schwaner, and more recently Hooze; with regard to Kutei, Von Dewall, C. de Groot, and Hooze; with regard to the northern States, Von Dewall, and in recent times, Hooze.

according to Hooze; thus, near Passir, in the various rivers flowing into the bay of Adang, in the bay of Balik-Papan, in Kutei (Samarinda) and Berau (G. Tabor).

The Tertiary beds in E. Borneo were first made known by the search for coal on the island of (Pulu) Laut.

Pulu Laut.[1]

On this island the Tertiary formation is only known on the strip of the coast lying opposite to the straits of Laut. The coal-bearing sandstone-stage (*a* Eocene) is here much disturbed by intrusions of andesite (augite-andesite of the Tebetung mountains). From the river Palinka to cape Pamatjingan, the strike varies from north-north-east to east-north-east, the dip (near cape Pamatjingan = 14° to 15°) is towards the sea, and only in one place towards the interior.

Eruptive rocks, andesites, have broken through the strata in two places (near cape Kamuning the eruptive rock is in contact with the coal seam).[2]

One rock is crystalline and granular, and of a greenish-grey colour, with separated crystals of augite and felspar. Sp. G. =2·8 (dolerite according to De Groot). Another is compact, greenish-grey with dark-green crystals of augite (anamesite, according to De Groot). They are associated with tuffs and tuff-conglomerates;[3] and with a greyish-brown rock, containing a yellowish-white zeolitic mineral, and cavities filled with chalcedony. These rocks form a reef running into the sea, and also occur as dykes, running into the brooks Palinkar and Sigan. Another rock consists of a greyish earthy mass, with conchoidal fracture and rough

---

[1] Investigations of C. de Groot in the beginning of the fifties, and of Hooze in the eighties.

[2] De Groot (S. 23 in the Jaarboek, p. 60-70) speaks of basalts, dolerite, anamesite, basaltwacke and amygdaloid. No microscopic examination, however, was made.

[3] V Basaltwacke amygdaloid, according to De Groot.

surface; it contains grass-green crystals of augite, and greyish-green, brown patches, which here and there contain white crystals of labradorite.

Mount Sebetong also consists of these rocks. Intrusions of andesite are also mentioned by Hooze as occurring on the island of Sebukut (augite andesite), and in the bay of Pamukan (quartz-bearing hornblende-andesite with tuffs).[1]

Eocene strata and coal-bearing sandstones, alternating with shale, occur on the small island Suwangi, on the straits of Laut. They lie round the hill which forms this island, and have a dip of 17° to 20°.[2]

It is not yet known whether the marl-stage is developed on the island of Laut Coral-limestones, however, must occur, as pebbles of bluish-grey, and yellow; coral-limestones have been found in two places in Miocene strata on the south-west coast.[3]

Southern States: Kusan, Tanah Bumbu, Passir.

As already mentioned, the Eocene extends from the island of Laut to Tanah Bumbu, where it was formerly known to occur in the Klupang and Pamukan bay, and its presence has also been confirmed by Hooze in recent years. North of the latter bay Eocene formations no longer occur, according to Hooze. They appear to occur, however, in the interior, near the mountain-border of the southern states; and this is made more likely by the great extent of the hill-land,[4] the height of which, according to old determination, is, in Kusan, several hundred feet, in Tanah Bumbu,[5] 150-200 feet, in Passir,[6] 300 feet; the boundary with Kutei, is also a hilly high-land.[7]

In Kusan, coal is said by[8] the natives to occur on the river

---

[1] Java Verslag, 1885, II.
[2] C. de Groot, S. 23, in Jaarboek, p. 63.
[3] Ib., p. 61, 62.
[4] Weddik E. 3.
[5] Schwaner E. 5.
[6] Verbeek S. 41, p. 115.
[7] Hooze E. 14 p. 24.
[8] Verbeek S. 41, p. 114.

Batu litjin, three days journey up-stream, and probably also in other places.[1]

In Passir Eocene strata no longer occur on the coast according to Hooze; but in the interior they seem to be present in the neighbourhood of the mountain-land, as Von Dewall found seven coal-seams in a hilly district near Bussui, at the east foot of the Susubang mountains, containing coal of good quality.[2]

Intrusions of andesites also occur here. Hooze mentions them in the rivers of the state Kusan (hornblende-andesite, and in the Bay of Pamukan.[3]

The marl-stage has, up to the present only been found in the Bay of Pamukan.[3] On the right shore of the mouth of the river Sampanahan, the mountain Batu besar is seen to possess a regular sequence of quartz-sandstone (stage α), with two coal-seams (of 1·10 and 1·75 metres respective thickness), and beds of clay-ironstone; then marl-beds (stage β), and Orbitoidal limestone (stage γ).

The distribution of the limestone-stage, *i.e.*, the coral reefs, is, in general, pretty well known. It appears to form an almost unbroken series extending along the mountain-border, towards the northern boundary of Passir. It forms steep rocky cliffs with caves, into which the rivers sometimes disappear (*e.g.*, the river Guntung and Kusan, Raja bekkat in Passir).

The height of the hills is from 400 to 600 feet, and limestone rocks occur in the Kramu mountains, up to a height of 800 feet.

In Kusan, limestone-rocks occur in the river-basins of the Kusan and the Batu litjin, cropping out along the mountain-border. Near Pamulawang the district is covered with limestone-rocks, and on the river the mountain Batu radjah, 600 feet in height, forms an imposing object.[3]

---

[1] Nieuwkuyk E. 12. [2] Weddik, E. 3. [3] Java Verslag 1885 IV.

In Tanah Bumbu[1] the coral reefs follow the mountain border, and are marked on Schwaner's map. In the bay of Pamukan, Hooze found the Orbitoidal limestone on the right bank of the river Sampanahan.[2] In Passir the limestone cliffs follow the mountain-border. Von Dewall found limestone-rocks from Sabung-Turang to the point where he crossed the boundary mountains,—namely at Mt. Batu hadji, the eastern spur of the Kramu mountains.

Up to the present fossil-evidence is wanting.

Kutei and the Northern States.

The Tertiary formation is very little known in Kutei and the Northern States; it has only been closely examined in those places where coal has been sought for.[3]

It appears, however, to be greatly developed in these states. In general, the hill-land is very near to the coast; for, looking from the coast low hills[4] are seen skirting the plains, or, perhaps, a low mountain-chain with curious contours,—probably the limestone formation.[5] The view from the mouth of the Berau is said to be especially beautiful, and the state Berau, seen from the sea, has been called the Switzerland of Borneo.[6]

According to more recent investigation, and in Hooze's opinion, the Eocene does not occur in the places examined; but it is possible that in the southern states it extends more into the interior, forming here, perhaps, a basin in the district of the river Mahakkan, as in S. and W. Borneo.

With regard to the coral reefs, it is known in Berau that an enormous limestone-rock (Batu Kayan) can be seen from the coast.[7]

High limestone rocks (coral reefs) extend along the

---

[1] Schwaner, E. 5.
[2] Java Verslag, 1885, IV.
[3] Samarinda, Gunong Tabor.
[4] Bock, S. 44.
[5] Gallois, E. 9.
[6] Von Dewall, E. 6.
[7] Hageman, E. 7.

Northern side of the mountain-chain, separating Kutei from Berau. These are known as Batu putih, and their white cliffs can be seen from the mouth of the Berau. A boulder of coral-limestone was also found by Hooze in a brook in the neighbourhood of the river Kaleh, near Gunong Tabor.[1]

The G. Suikerbrood in Berau also shows, as pointed out by Schouw-Santvoort,[2] the tectonic structure of limestone-mountains, viz., table mountains with steep declivities. But whether all the limestone rocks visible from the east coast, are Tertiary coral-reefs, is very questionable; a part might also be Palæozoic, another Upper Tertiary.

Miocene.

Miocene strata have also a wide distribution on the east coast. We have already seen that Upper Tertiary strata occur in E. Tanah Laut, on the rivers Sibuhur, and Assem-assem, and also near Tanjong Batu. These are continued in the State Kusan,[3] where they occur near the coast, and are seen on the island of Laut, near Tanah merah.[4]

More to the north, in the island of Soreng, in the bay of Pamukan, there is an Upper Tertiary formation;[5] and the latter also occurs in the bay of Adjang and Balik-papan.[5]

In Kutei, Hooze holds the coal formation of Samarinda and neighbourhood partly for Miocene, partly for Oligocene, and the same applies to the coal near G. Tabor, on the river Berau. According to this view Miocene strata are greatly developed on the east coast, and in the more northern states.

Geotectonically, the Miocene beds form a low hill-land. From a petrographical stand-point it is remarkable that the recent Tertiary strata near Tanah merah, on Pulu Laut, consist of sandstones and shales, containing pebbles of coral-limestone and coal, together with many fossils.

---

[1] Hooze, E. II., p. 15 and 28.
[2] Schouw Santvoort, E. 11.
[3] Java Verslag, 1885, IV.
[4] De Groot, S. 23, and geological map.
[5] Java Verslag, 1886, I.

In Kusan, the strata consist of beds of limestone, marl, and sandstone; and on the island of Soreng, of light-green marl, with numerous recent shells. In Kutei, on the river Mahakkan, the lowest member is a fine-grained sandstone, alternating with shales. This is overlaid in places by a light-grey marly sandstone, and coral-limestone, which here and there shows the cellular structure of corals (G. Lawas). The marly sandstone appears to overlie the limestone.[1]

Determination of the Age.

The coal bearing strata of the island of Laut were placed by C. de Groot with the Eocene, and he gave the same age to the coal-formation near Pelarang, on the river Mahakkan in Kutei. Petrographically the strata consist of compact, micaceous sandstones, alternating with grey shales, and containing nodules of grey-ironstone, as in the coal-formation in Pengaron. Again, the finding of Cyrena Bornensis, a fossil characteristic of the sandstone stage in Pengaron, is a proof of their identity in age.[2]

The Indian mining-engineer, Hooze, has, however, a different view, which is founded on more recent investigation. He also places the coal-formation in Pulu Laut with the Eocene, but that of the river Mahakkam is, according to him, of Miocene age; and, further, he distinguishes between Lower Miocene beds (Oligocene) and Upper Miocene. In the Oligocene he includes the coal-seams of the mountains Batu Panggal, Damar, Salili, Prangat and Pelarang; while in the Upper Miocene he includes the coal-beds of Tenggalung Ajam and Gunong Talok Lerong. He bases these views on rock-composition, and more especially on the different amount of water contained in the coal of the two formations.[3]

---

[1] Hooze, E. 14.

[2] De Groot S. 23, p. 81, and Verbeek S. 41, p. 115.

[3] Hooze E. 14 p, 57.

The Eocene coal of Pengaron and of Pulu Laut contains four to six per cent. of water; the Oligocene coal in Kutei contains nine to fourteen per cent.; and the Upper Miocene coal nineteen to twenty-five per cent.

Similarly Hooze includes the coal-formation of the state Berau (Gunong Sawar), in the Miocene, also on account of the higher per-centage of water in the coal.[1]

Detailed results of these investigations are, however, not yet published, and the age is, consequently only suppositious, since palæontalogical proofs have not been furnished. But this is the first attempt that has been made to sub-divide the Upper Tertiary formation of Borneo.

North Borneo.

Our knowledge of the Tertiary beds of North Borneo is as deficient as it is with regard to the structure of the mountain-chains. Only on the island of Labuan have they been more carefully studied, namely by Motley. In the remaining districts only their occurrence has been noted. If we judge by the description given of them, we must conclude that they have a wide distribution: and they present the same character as in the rest of Borneo, consisting of sandstones, with intercalated beds of coal and limestone reef in which edible birds' nests occur.

Eruptive rocks of younger age, such as have traversed Tertiary strata in other parts of Borneo, are also mentioned as occurring in North Borneo; it must not be forgotten, however, that these rocks have not been submitted to exact petrological determination, and that, perhaps, some of the so-called syenites and diorites may include andesites.

The area occupied by Tertiary beds in North Borneo must

[1] Hooze E. 13 p. 28.

be a very large one, especially if we draw our conclusions from the wide distribution of the localities where coal (belonging to the sandstone beds) is found. Tertiary formations often extend to the coast, and there form high, rocky cliffs, which impart a picturesque character, not generally found in the south of Borneo, at least, in parts inhabited by Europeans.

Sarawak.[1]

In Sarawak, a hilly formation comprising sandstones and limestones extends from the coast to the boundary-mountains. Exact details as to its composition are as yet wanting; we only know that the coal-bearing sandstone (stage *a*) occurs, and that there are coral reefs.

In the district of Lundu, we find a strip of limestone from which edible birds' nests have been collected.[2] In the Sarawak district proper, the limestone is continued above the point of union of the two branches of the Sarawak stream.[3] Further to the east, the limestone beds appear to be wanting, or only to occur sporadically, for they are not mentioned in the reports.

These limestone beds are penetrated by numerous caves (some 250 feet high); they dip at a high angle, and contain many fossils.[4] To the south the limestone hills are succeeded by a more undulating country, consisting of sandstones, in which excellent black coal occurs in places, for instance, in the beds of the rivers Lingga and Simunjan.

Intrusions of andesite are also found in Sarawak. They

[1] By far the largest part of our information has been collected by A. H. Everett.

[2] Everwyn W. 39, p. 82.

[3] Crocker N. 34, and map.

[4] Low, N. 1.

are expressly mentioned in the upper Sarawak district proper, and described as "hornblendic trap rocks."[1] These recent eruptive rocks have often disturbed the bedding of the coal-bearing strata. In Sarawak proper, they are described as basalts and felspar-porphyries, occurring in hills, or as dykes in the lowlands.

These eruptive rocks are older, according to Everett, than the Diluvium—the youngest stratified formation—and younger than all other formations.[2] A large proportion, however, of these formations—most probably the whole of the ore-bearing limestone hills—belongs to the Carboniferous Limestone (even Everett calls it Palæozoic ?).[3]

Of the easterly districts no details are known. But, to judge from their geological relations, the Tertiary beds are probably developed in the inlying districts.

Brunei and Sabah.

In Brunei the Tertiary beds are first seen in the drainage basin of the Barram stream, about eighteen geographical miles from the coast. Not far from Langusan rises a limestone hill, Batu Gading (a steep, deeply-fissured hill, consisting of a white rock). It is the spur of a limestone-chain, and contains numerous caves.[4]

In the bay of Brunei, on the other hand, the Tertiary coal-bearing sandstone hills extend down to the coast.

The Limbang river, in its lower and middle course, traverses a hilly country (500 to 1,500 feet high), consisting of hard sandstone (which also contains coal, for instance, in the Madalam tributary). The strike of the beds exposed in this river is north-east, with a dip of 45°, and north-north-west, with a dip of 80°, in the middle course of the Limbang.

---

[1] Everett, N. 23.

[2] Ib., N. 24.

[3] Ib. N. 23.

[4] St. John, N. 9.

Limestone rocks are also found here; in part they are Tertiary coral reefs, in part older beds.

On the island of Labuan the Tertiary beds are greatly developed, and contain coal, according to J. Motley.[1]

Two lines of sandstone hills (about 300 feet high) extend in a north-easterly direction, with variable dip (for a section of the coal-bearing strata see "coal").

A part of the surrounding smaller islands consists of sandstone; but the islands Pulu Burong, Belulang, Eau, consist of a yellow, porous, siliceous, coral limestone, which is in part stratified, and often resembles marble.[1] The Tertiary beds extend in parallel lines of hills along the coast, taking in the nearer islands, for about ten miles[2]; and towards the interior, to the river Sequati, being succeeded by older limestones.[3] Tertiaries are also found in the Bays of Marudu and Sandakan, and in the south on the river Kinabatangan. The sandstone beds on the western bank have an east and west strike, and a dip of 45°; in places they alternate with steep limestone rocks.[4] This formation appears to make up a great part of the Alcock province, and the northern part of the East Coast province, extending often right down to the coast, as in the Bays of Labuk and Sandakan. In places, however, Culm-measures predominate, and the two formations have yet to be separated.

In the upper course of the river Kinabatangan, above Pinungah, sandstone occurs, interbedded with shales. It is exposed on both banks, and contains coal and clay-ironstone. It has the true character of the Tertiary beds. The sandstone and shales are called Kinabatangan stone by Hatton.

The sandstone which here also alternates with shales, contains coal-seams and clay-ironstone.

---

[1] Motley, N. 7.
[2] J Peltzer, N. 33, p. 378.
[3] Hatton, N. 48.
[4] N. 40, p. 543.

Limestone reefs occur in several places along the coast. No younger eruptive rocks have as yet been noticed.

Determination of the Age of the Beds.

Motley determined the age of the coal-bearing strata in Labuan as Eocene. He found a considerable number of badly preserved fossils in Labuan.[1] Among them there is one species each of the following:—Pyrula, Turbo Fusus, Oliva, Arca, Solen, Terebratula; two species of Terebra; three species of Cerithium, and some Crustacean remains.

The plants have the structure of Dipterocarpeæ, the resemblance being supported by the presence of a yellow resin. Remains of slightly compressed trunks of great dimensions, have been found. Motley measured one of sixty feet length and eight feet breadth. The trees have also been found in an upright position, and are partly silicified, partly converted into a fine powdery coal. Among the plant remains nine species of Dicotyledons have been distinguished, two of which remind one of Barringtonia; further, two or three species of fern, and four or five species of palm.

In another place, Motley found two species of Cardium, one species of Tridacna, one species of Arca, Ostrea, and Tellina, and four indeterminable species; further one Murex, one Turbo, one Serpula, two Cerithiums (or Terebra), one Pecten, one Ostrea, and two indeterminable. All these fossils indicate a very recent age.

A study of the coal-bearing strata in their petrographical and geotectonic aspects, and of the coal itself, as well as of the above-mentioned fossils, leads to the conclusion that we have here to do with the same Tertiary formation as in the remaining part of Borneo.

Geyler[2] has also determined some plant-remains on the

---

[1] J. Motley, N. 7. [2] Geyler, N. 54.

island of Labuan that were collected by Nordenskiöld on the *Vega* expedition. The impressions were more or less defective, and half of them in such a fragmentary condition, that exact determination seemed impossible. Yet Geyler believes that some forms can be regarded with moderate certainty as belonging to Pandanus, Ficus, Dipterocarpus, Calophyllum, while most of the others were referred by him to the most nearly related types of the living flora.

The fossil flora, as represented in the collection made in Labuan, contains sixteen families, and thirty species. The families are the following:—Pyrenomycetes, Filices, Musaceæ, Paudaneæ, Moreæ, Laurineæ, Rubiaceæ, Apocyneæ, Myrsiceæ, Sapotaceæ, Myristiceæ, Dipterocareæ, Clusiaceæ, Combretaceæ, Melastomaceæ, Papilionaceæ.

Of especial interest is the occurrence of the tropical family of the Dipterocarpeæ; since this shows that the climate of that period was tropical, and that the flora had a tropical appearance. All the fossils of Labuan can be referred, with more or less certainty, to types now living in the tropics.

Geyler does not attempt a determination of the Tertiary flora, because the fossil remains are only partly known; a comparison with the other Tertiary floras of the Sunda islands is, therefore, as yet impossible.

The coal-bearing strata in the mouth of the river Berau also appear to be of Tertiary age.

Useful Minerals.

As in the rest of Borneo, coal-seams are not wanting among the sandstone outcrops. Concretions of clay-ironstone are also present in the shales. (For details see "Coal in North Borneo.")

SOUTH BORNEO—MICROSCOPIC AND CHEMICAL ANALYSIS.[1]

	Hornblende-andesite.			Augite-andesite.					
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.
SiO_2 ..	58.80	64.20	65.47	55.70	49.—	50.53	53.55	55.13	58.80
Al_2O_2 ..	18.83	16.27	18.52	21.04	18.67	17.14	17.66	18.46	14.27
Fe_2O_3 / FeO }	8.07	4.53	2.73	10.36	10.06	10.53	9.67	11.67	11.66
Ca ..	5.40	4.34	4.13	7.80	4.53	7.07	3.36	7.67	10.47
Mg ..	1.05	1.99	1.31	1.13	5.06	6.40	3.05	3.88	5.55
Ka ..	0.44	1.97	1.98	0.36	2.54	2.23	2.28	0.74	0.34
Na ..	4.56	3.39	3.56	2.71	4.42	1.65	3.36	2.24	0.72
H_2O. and loss	2.05	2.93	2.33	1.20	5.46	4.20	1.56	1.00	3.27
Total,	99.20	90.62	100.03	100.30	99.74	99.75	98.89	100.79	100.08

No. 1. From Riam-Balei: yellowish-grey groundmass, with glassy base, and felspar, hornblende, and magnetite; porphyritic crystals of felspar.

No. 2. From Pengaron: felsitic groundmass, porphyritic crystals of plagioclase.

No. 3. From Tiwaän and Batara-Bulu: felsitic groundmass, porphyritic plagioclase, quartz, magnetite, hornblende.

No. 4. From the R. Antougin: groundmass, with glassy base, felspar, magnetite; porphyritic crystals of plagioclase, augite, olivine.

No. 5. From the hill Batu-di-tanam: groundmass, with glassybase; porphyritic crystals of plagioclase and augite.

No. 6. From the hill Batu Idju: no glassy base; porphyritic crystals of plagioclase and augite; calcite-amygdules.

No. 7. Battong-Bedara: like No. 5.

No. 8. Between Rantau Balei and the R. Tiwaän: groundmass, with glassy base; porphyritic crystals of plagioclase, augite, hornblende.

No. 9. R. Kalaän: groundmass, containing augite, magnetite, and plagioclase; porphyritic augite crystals.

IV. GEOLOGY OF THE PLAINS.—DILUVIUM.[2]

Like the Eocene formation, the Diluvium plays an important part in the geology of Borneo.

Just as coal was found to be characteristic for the Eocene beds, so the Diluvium contains abundant gold, platinum,

[1] Verbeek S. 41.

[2] Drift of English Geologists. A more detailed description will be found under the head of "Gold and Diamond drifts." ("Seifen."

and diamonds. The coal, however, has been little sought after, whereas the Diluvium gold has been worked for centuries by the natives, especially by the Chinese.

Another point of resemblance between the "hill-land" and the Diluvium is apparent in their distribution. The former surrounds the mountain-land, like a belt; the latter forms a similar zone round the hill-land; in places, however, it occurs in it, even appearing in the mountain-land itself. It covers the flanks of the mountains, and fills up depressions in them, and forms a part of the subsoil of the lowlands.[1]

We must distinguish between marine deposits and river-drift. The latter follows the rivers, even accompanying them into the mountain-land. The former is only found on the margin of the hill-land, and is to be regarded as a shore-formation.[2]

Geotectonically the Diluvium is easily separable from other formations: it may be described as solid flat-land, in contradistinction to the marsh-, hill-, and mountain-land.

In part it consists of flat districts, partly of gently-undulating plains. These are well illustrated in Tanah-Laut.[3]

In general its composition is everywhere the same. Its highest bed consists of a partly pure, partly sandy clay, which, towards the bottom, becomes more sandy, the sand-grains, at the same time, increasing in size.[4] The conglomerates consist mainly of quartz-pebbles, but also of pebbles of different eruptive rocks, such as gabbro, diorite, granite, etc.; it also contains pebbles of the Tertiary strata, such as sandstones, coral-limestone, etc. Between these pebbles there is more or less of a clayey earth, containing gold, diamonds,

---

[1] Schwaner, S. 16, I. p. 26.

[2] Horner and Schwaner call it "Pebble-formation." and the former also speaks of it as "coast-formation."

[3] Posewitz, S. 53.

[4] This clay-bed is often difficult to separate from the decomposition-products of the argillaceous sandstones and shales, which also form a pure or a sandy clay.

platinum, magnetic iron-ore, and chromite. The pebbly-bed is often united by a siliceous cement, which is so hard, that it has to be worked with the help of the crowbar. With regard to the thickness of the various beds, there are considerable differences.

The Diluvium is underlaid by the "old slate-formation," and older eruptive rocks (the former altered into clay, the latter quite weathered), or by the Tertiary formation. On the one side, the Diluvium succeeds the hill-land; on the other, it is bordered by marshy low-lands. No sharp distinction, however, can be made between it and the latter; they pass gradually into one another. While flowing through Alluvium the river has low banks, but these reach a considerable height in the Diluvium, and the river flows between high, perpendicular clay-walls, as in a narrow gully. The bedding is horizontal, or only slightly inclined (at the border of the hill-land).

South Borneo.

Like the hill-land, which it borders, the marine Diluvium forms in S. Borneo a gulf-like expanse which is open towards the Java sea, and terminates in the Bay of Sampit.

Beginning near Tabanio in Tanah-Laut, it extends in a north-easterly direction, parallel to the mountain-chain. Martapura lies on the borders of the dry plains (*feste Flachland*); Rantau, Kendangan, Barabei, are well in it; while Amunthei lies near the border, but in the marsh land. From this point, where it has the greatest breadth, the Diluvium extends towards the Barito, which it reaches near Benua asam, at 1° south latitude. At this place the dry plains are about forty geographical miles distant from the coast. In the other river-basins the Diluvium approaches the coast between the rivers, sending tongues into the marsh land; and reaches it, as already mentioned, near Sampit Bay.

It is found, further, in the river basins of the Djellie, Kotaringin, Kwala Kuming, and Pembuang, the marshy gulfs of which are surrounded by a belt of hill-land.

It has already been mentioned that the fluviatile Diluvium extends far into the hill-land, and even penetrates the mountain-land.

C. de Groot gives the following details of a section near Martapura:—[1]

Diluvium.

Soil	0·10	metre
Clay	1·00	„
Blown sand	1·10	„
Diamond-earth	0·75	„

Miocene.

Ferruginous sandstone	3·40	„
Sandy clay	2·09	„
Reddish-green clay	0·70	„
Blackish, sandy clay, with pieces of coal and fragments of shell	0·20	„
Grey clay with shell	4·87	„
	14·21	„

In the district visited by Dr. Schwaner, Diluvium is widely distributed, *e.g.*, in the upper course of the river Patu, in the central district, and in the basins of all the rivers.

"Beds of conglomerate containing sand, clay, and gold, are found in the hill-lands, and on the borders of the low-lands."[2]

The distribution of the gold (auriferous drift) is in itself sufficient to determine the extent of the development of the Diluvium.

Ores.

Gold, platinum, iron-sand, and in places iron-sandstone, as for instance, in Telokh Gaudis.[3]

---

[1] C. de Groot, S. 13. p. 51. [2] Schwaner.
[3] Schwaner S. 16, I. p. 26.

West Borneo.

In W. Borneo the Diluvium is as widespread as in S. Borneo.[1] It forms a part of the great plain, lying along the borders of the river Kapuas, and forming a great part of the plain of the river Melawi.

The Diluvium is also of widespread occurrence in the Chinese districts, and in Sukadana; it is of special importance in the former, because there it contains gold, the Chinese districts being the richest in the whole of Borneo.

At the foot of the various mountain-chains, and on their declivities, as in the Skadau, Udu, and Pandan mountains, and in the neighbourhood of Mandhor, the Diluvium occurs in beds of one to two metres, forming terraces; and similarly all the river valleys which run up into the mountains, are of Diluvial origin. Its composition is the same here as in S. Borneo.

The same is the case in Sukadana. The Diluvium occurs among the "mountain-formations," and along the boundary between the Alluvium and the older formations, as for instance in the Sungei Pawan above Muara Kajung to Mount Sablangan.

Ores in the Diluvium.

Gold occurs nearly everywhere, especially in the "Chinese districts." Diamonds, cinnabar, and iron-sand are also found; and tin-sand in very small quantities in Abut, Sukadana.

North Borneo.

The drift has a widespread occurrence in the north-western parts. It extends in a broad band from Sarawak to the neighbourhood of the bay of Brunei, reaching from

[1] Jb. v/h M. 1878, p. 135; 1879, I.; 1883 I. p. 6; 1885, I. p. 119.

the base of the hill ranges, down to the coast, where it borders on the marshy land.

In Western Sarawak the Diluvium seems to be widespread, for its presence is indicated by the occurrence of placer-deposits of gold and diamonds. Looking from Santubong Hill, near the mouth of the river Sarawak, the view extends over a wide flat plain.[1] In eastern Sarawak the Diluvial plain increases in extent, presenting a flat or slightly undulating surface, in which only a few hill-ranges appear. The flat region, between the rivers Sarawak and Batang-Lupar, is broken by the occurrence of a few isolated hills,[2] and near the river Bintulu there are two fine ranges of hills. In the neighbourhood of the river Sarawak the Diluvial plain extends to above the delta; in that of the river Batang-Lupar it reaches to the village Marup; and near the river Rejang far beyond the village Kanowit. Its greatest lateral extent (thirty miles), is between the rivers Barram and Rejang.[3]

In the neighbourhood of the river Barram the Diluvium extends for a distance of eighteen miles towards the interior, nearly as far as the village Langusan; and in this plain, not far from the coast, are two hill-ranges,—Silungan, 1,500, and Lambir 1,550 feet high.[4]

The river Limbang also flows in the plain of a broad valley which narrows towards the interior.

From the bay of Brunei to the north-eastern point of the island, Diluvial deposits occur only in isolated patches, and then mostly as fluviatile Diluvium (river drift). In this district hilly ground and mountain-chains abound, while in the western district only occasional spurs extend towards the coast.

Small plains are here the exception. They occur, for instance, near the river Tampassuk,[5] and on the island of Labuan.[6]

---

[1] Boyle N. 11.
[2] Low N. 1.
[3] Burns N. 3.
[4] St. John N. 9.
[5] St. John N. 9.
[6] Motley N. 7.

Diluvium occurs again in the north-western part of Sabah, for instance, on the western side of Marudu Bay, Labuk bay, and in the country lying between them. So also among others, the rivers Labuk and Kinabatangan may be mentioned as possessing a Diluvial valley-plain extending far inland.[1]

Diluvial deposits are also found in the interior. Thus Pryer mentions, as very remarkable, a Diluvial plain 4,000 square miles in extent: it is bounded on the south by the hills of the Unsang peninsula; on the north by the Labuk hills; and on the east by the high mountain-chain.[2] A similar plain is situated, according to Hatton, above Liposu, between the rivers Labuk and Kinabatangan, and also in the neighbourhood of Kina-balu. In this connection may be mentioned the "table-land" east of Kinoram, which is covered by boulders. Further, each river has its Diluvial plain, and the distribution of these recent deposits seems here also to be pretty wide-spread.

The lake south of Kina-balu,[3] the existence of which has been so often asserted and denied, is probably a similar Diluvial plain.

It was mentioned as early as 1812, being asserted to be the source of many rivers. Its depth reached, in places, five to six fathoms, and it was said to be studded with islands.[4] Rienzi and De Crespigny marked it on their maps as being situated south-east of Kina-balu.[5] St. John when ascending Kina-balu, saw no lake, but noted a plain in a southern direction.[6] Giordano and Bove could learn nothing of its existence from the natives in the vilage of Kiang.[7] The same account is given by Pryer and Witti, who travelled in this district. The name "Danau" is characteristic for such plains.[8] This gives an indication of their mode of

[1] Fr. Hatton N. 48.
[2] Pryer N. 39.
[3] Posewitz N. 50.
[4] Crocker N. 34.
[5] Bove N. 20, p. 272.
[6] St. John N. 10, p. 222.
[7] Bove N. 20, p, 272.
[8] Fr. Hatton.

origin, for *Danau* denotes a lake. Thus we are led to the explanation that the present plain was formerly a lake, which, in the course of time, became marshy, and ultimately dry, resuming its marshy character in the rainy season.

Ores.

Gold in Sarawak and Sabah. Diamonds in Sarawak.

EAST BORNEO.

The occurrence of Diluvium in E. Borneo is interesting, inasmuch as it shows a similar distribution in the various districts, as in Sarawak or Sabah. In the southern states a broad strip of it surrounds the hill-land, extending parallel to the mountain-chain, and approaching the coast to within two geographical miles; but that it also occurs in the hill and mountain-land is shown by the gold and diamond washings in existence there. This is the Sarawak type of Diluvium.

In Kutei it also forms a part of the great plain of the river Mahakkam, occurring along its borders. Here it resembles a similar occurrence in the plain of the river Kapuas in S. Borneo.

In the northern states—Berau, Bulongan, Tidung, it appears to be of restricted occurrence, since the hill-land mostly extends down to the coast, as in Sabah. But we have very little positive information with regard to these districts.

Ores.

Gold, diamonds, iron-sand.

Age of the Diluvium.

(See age of the gold-washings.)

V. GEOLOGY OF THE MARSHES.—ALLUVIUM.

South Borneo.

Alluvial formations are of wide-spread occurrence in Borneo. In these deposits we have to distinguish between recent marine deposits, fluviatile deposits, and recent coral-formations.

The river-deposits show the greatest distribution, especially in S. Borneo, where they form extended marshy plains. Then follows W. Borneo; while in the east and north of the island they are least developed.

The marshy plain penetrates farthest into the interior in the basin of the river Barito, namely, about thirty-eight geographical miles, reaching the village of Benua-assam on the west, however, it approaches the sea-coast in a north-east and south-west direction, thus diminishing in extent. The Alluvium of the Kapuas river extends for a distance of only twenty-eight geographical miles, namely, to the village of Kotta Baru, and that of the Kahajan only seventeen geographical miles, to Muara Rawi.[1] Between the different streams tongue-like strips of Diluvium project to the marshy plains. In the western part of S. Borneo the hill-land extends between the rivers Sampit, Pembuan, Kotta-ringin and Djellei, down to the sea coast, thus restricting the the marshes to the mouths of the rivers. The eastern border of the marsh-land is approximately parallel to the mountain-land, the lower course of each river flowing from these mountains is surrounded by marshes down to its union with the Barito. The marshy-land extends, in the neighbourhood of Tabanio, in the Tanah-Laut district, as far as Martapura and Amunthei, and then approaches the Barito in a north-westerly direction.

But marshes also occur in the middle of the Diluvium,[2]

---

[1] Schwaner S. 16 I. 149. [2] Ib. S. 16, II. 105.

in the hill-land, and even in the highest mountain-lands; thus Mount Kamingting is surrounded by swamps, from which the river Djaloi takes its source; the same is the case with the tributary on the left side of the river Lauung.

In the hill-land near Pengaron the plains surrounding the hills are swampy during the west monsoon; and similarly marshes are marked on the map in the valleys near Tjempaka.[1]

The river-deposits are composed of a dark-brown, black, or bluish clay, which is often rich in humus in its upper layers; in the lower layers it is of a harder consistency.

It is often mixed with, or traversed by, seams of sand, the latter, as a rule, occurring on a lower level.

The thickness of the Alluvium is not known, but it appears to be considerable. It was bored through to a depth of 217 metres in making an Artesian well in Bandjermassin.[2] To a depth of thirty metres it consisted of clay rich in humus; then it became firmer, and extended to the depth mentioned, of 217 metres. Here and there small layers of sand or flint were found.

The boundary with the Diluvium cannot be sharply drawn.

The Alluvial marshes rise but little above the sea-level. At a distance of thirty-five geographical miles from the coast, it is only eight metres. This is shown by the great distance to which ebb and flow can be observed in the rivers, and further, by the great area which is annually flooded in the rainy season. For example, in the Barito river, ebb and flow can be observed at a distance of fifteen geographical miles from the coast (as far as Muara Pulau, the end of the great delta of the Barito), while in times of flood, during the

---

[1] Jb. v/h M. 1874; II.. 88, and 1882, II.

[2] During the first boring for water, a depth of 217 metres had been reached, when an accident put an end to further operations. Two water-bearing beds were penetrated, but these gave very little water. Two other borings did not reach the water-bearing strata. (Jaarboek v/h. Mynwesen, 1880, II. 55, and 1882, II. 115.)

rainy season (west monsoon), the influence of the tide is felt as far as Pamingir, a distance of eighteen geographical miles; in the dry season, on the other hand, it is often felt as far as Buutok, thirty-five geographical miles.[1]

In the tributary Negara the influence of the tide is observable at Margasari, three geographical miles from its mouth;[1] in the river Karran as far as Danau;[1] in the river Riam Kiwa as far as Martaraman, five geographical miles from the coast,[2] and in the powerful tributary Kapuas as far as Takison.[3]

In the Kahajan the tide is perceptible during the west monsoon as far as Pilang, a distance of twelve geographical miles; during the east monsoon as far as the mouth of the tributary Rungan, a distance of sixteen geographical miles.[4]

The area flooded daily in the basin of the river Barito[5] is estimated by Schwaner[6] at 160 square geographical miles, or one-twelfth of the whole river basin,[7] to which during the rainy season, 420 square geographical miles must be added. Consequently, during the west monsoon, 580 square geographical miles, or a little more than one third, are flooded.

In the basin of the river Kahajan over 200 square geographical miles are flooded daily, while in the rainy season 340 square geographical miles are under water.

The appearance of the landscape during the west monsoon is quite different from that presented during the dry period,

---

[1] Schwaner S. 16, I. p. 30–94.

[2] Jb. v/h M. 1874, II. p. 47.

[3] Schwaner S. 16, I. p. 30-94.

[4] Ib. S. 16, II. p. 9.

[5] Schwaner estimates the basin of the R. Barito at 1,900 square miles; that of the Kahajan at 762 square geographical miles; and the total area of the rivers of S. Borneo at 4,549 square geographical miles (Borneo II. p. 104-140). Von Gaffron, on the other hand, cstimates the basin of Kottaringin, the Pembuas, and the Katingan, at 1,300 square miles.

[6] Ib. S. 16, Borneo I. p. 2.

[7] Ib. S. 16, II. p. 105.

thus Schwaner[1] writes of the basins of the Pattai and Karrau:—"The level of the water shows in some places a difference of some twenty feet. During the rainy season a great part of the land is covered, the hills rising from the water like islands, while there is a free passage in every direction for small canoes. In the dry period, however, the traveller is obliged to travel on foot from one place to another."

Similarly the swampy districts have a very different appearance in the rainy and dry seasons, as I myself have observed. Near Negara, on the river of the same name, the waterway leads over marshy ground to the military fort on the mountain border. During my first journey to that place everything, as far as the eye could see, was covered with water: it appeared to extend to the mountain-chain skirting the eastern horizon, the foot of which is surrounded by steep Tertiary coral-reefs. In the midst of the flooded district one could see Negara, an important seat of industry, extending along the end of the great sheet of water, as if it were situated on an inland sea. In the swampy parts there were thick patches of rushes which formed welcome resting-places for dense swarms of mosquitoes; and the oarsman in threading his way is obliged to keep a sharp look-out in order not to lose himself, for should this happen, he would be compelled to lie-by till the following morning.

In the dry season the district bore quite another aspect. The immense sheet of water had disappeared, its place being taken by a black soil, traversed by numerous canals, and filled with clear, dark-brown water. During the dry season between Barabei and Amunthei, I could clearly distinguish the districts subject to periodic floods. The vegetation consists entirely of thickly tangled bushes, while the boundary was marked by the gigantic trees of the virgin forest.

---

[1] Schwaner, Borneo I. p. 97.

Marine-Deposits.—As far as I am aware accumulations of sea-sand on the coast and *coral reefs* do not occur.

Peat-mosses are mentioned in the districts Sampit and Katingan.

Michielson crossed an extensive peat-moss between the rivers Kalamanan and Tampaga;[1] further, in the lower river-basin of the Patai, Karrau, and Siong.[2]

Ores.

Gold, diamonds, and native copper occur in the river sands.

West Borneo.

The Alluvium is most wide-spread in the basin of the Kapuas.

The same relations exist here as in S. Borneo, but they are somewhat modified by the small extent of the Kapuas basin.

In S. Borneo the Alluvial plains extend for considerable distances in strips, having widths of about fifteen geographical miles, traversed by many large rivers. They retain their character for great distances, and are then replaced by the hill-land.

In the basin of the Kapuas the Alluvium is only spread over an area of eighteen geographical miles periphery reaching to the neighbourhood of Tajan, thirteen geographical miles from the coast.

This is the extended delta of the Kapuas with six mouths, having a sandbank before each.

Further inland the plain loses in great part its Alluvial character, consisting then of drift deposits, from which rise a few small hillocks. On account of the small width of the basin, the spurs of the hill-land extend to its middle line, while in the much wider basins of S. Borneo, these do not appear for a much greater distance.

---

[1] Michielsen S. 46. [2] Schwaner S. 16, I. p. 91–93.

The Alluvial plain in W. Borneo is divided into two parts:—the Kapuas plain proper, lying to the south; the Melahui plain, traversed by the powerful tributary Melahui. Between these two streams (the Kapuas and the Melahui) the hill-land comes in and curtails the development of Alluvium.

The Alluvium extends as far as Tajan; beyond this place the first elevations begin, and continue to show themselves here and there, but without modifying the real character of the landscape. For, looking from Mount Betong, in the neighbourhood of Skadau, an extended plain is seen, bounded on the south by hill-chains running in a westerly and easterly direction, and extending as far as Tajan on the Kapuas.[1]

In the neighbourhood of Sintang, thirty geographical miles from the coast, the hill-land closely approaches the Kapuas, and consequently bounds the lower part of its valley. Farther up stream, however, the valley gets broader, and in the neighbourhood of Salimbau forms a second wide basin, in which several lakes occur, both on the north and on the south.

From Mt. Sindoro, near Djonkong, there extends, towards the east and west, a boundless wooded plain, broken only by a few unimportant hill-ranges or by isolated hills. On the north-west and north-east there is a lake district, in which is situated Lake Seriang, with some small hill-ranges in the background, forming the boundary with Sarawak. On the south and south-east there are other hill-ranges, extending in an easterly direction, thus forming the water-shed between the Kapuas and the Melawi.[2] Looking in a southerly direction from the Kapuas stream, towards the north-east and south-east, one sees several hilly mountain-ranges, belonging to the mountain-land, some of which are of not inconsiderable height. The plain of the Kapuas appears to extend towards

---

[1] Everwyn W. 33, p. 36. [2] Ib. p. 19.

the interior as far as the neighbourhood of the "central mountain *massif*."[1] From Molo, which is about forty-three geographical miles from the coast[2] (on the Kapuas), everything is flat and even.

The Kapuas plain, accordingly, consists principally of two basins, separated, near Sintang, by the hill-land. In part it retains a marshy character, as in the great delta of the Kapuas, near Salimbau, and in the neighbourhood of the river-beds.

The greatest elevation[3] of the basin between Landak and Sanggau is near the northern boundary. Not far from Sintang it perceptibly decreases, and at Salimbau the level is the same as in the Kapuas delta, and remains so up to the foot of the mountain-land. Near Bunut, forty geographical miles from the coast, the plain is only a little higher than the sea-level.

Ebb and flow are perceptible as far as Tajan (fifteen geographical miles), and in the dry period as far as Sanggau (twenty-two geographical miles). Every year this delta is flooded in the rainy season, and similarly the upper basin (near Salimbau, Djonkong) is annually under water.

We have less information with regard to the plain of the river Melawi. It extends as far as Pinoh, where the river divides into its two chief arms—the Pinoh and Melawi—and in the basin of the latter, as far as Pinang. At this point the hill-ranges approach the river, and take the place of the plains.

In the northern districts the Alluvium of the Kapuas extends on the southern boundary as far as Landak. The coast land is flat, and mostly marshy. It consists of recent sea deposits and sand-dunes. Only at the mouths of the rivers Sambas and Palo, and near Cape Rassak and Datu,[4] are there hills.

In Mandor and Mampawa the Alluvium reaches to the

---

[1] Everwyn W. 33, p. 22.
[2] Ib. p. 23.
[3] Van Lynden, W. 11.
[4] Everwyn W. 33, p. 47, 78.

hills Djerat Semata,[1] and the present Alluvium of the rivers Sambas and Sebangkau (which formed an arm of the sea in post-Tertiary times), extends as far as the northern and western foot of the Skadau mountains;[2] while a few isolated hills rise up from the marshy plain (Simpadang and Planjau).

Every river has its marshy low-land. In the southern districts of Sukadana all the rivers have marshy plains, which extend for a distance of five or six miles from the coast. The whole coast of Sukadana is marshy, with occasional sand-dunes; in few places only do rocks occur on the coast.

Ores.

Gold, diamond, and iron-sand.

North Borneo.

The Alluvium is less strongly developed in North Borneo than in South and West Borneo; the bog-formation and the marsh-land of the lower river courses, are especially of less account here than in other districts. The cause of this is to be found in the great development of sea-sand on the north coast, which hinders the formation of morasses. It is the same case here as on the east coast of Bangka, already described by me.[3]

The district between cape Datu and the river Lundu is mountainous. But boggy ground extends from the latter to the Sadong river; it is traversed by numerous intersecting canals, which are used by the natives to shorten their water routes.[4]

Further to the east the bog-formation occurs only in the river-deltas.

---

[1] Everwyn W. 33, p. 47, 78.

[2] Jb. v/h M. 1884, II. 246.

[3] Petermann's Mittheilungen, 1886, Heft 7. *Die rezenten Bildungen auf der Insel Bangka.*

[4] Crocker N. 34, p. 194.

The delta of the river Sarawak is marsh-land, and the lower portion of the district traversed by the river Sadong is swampy for forty miles.[1]

The alluvial plains of the Batang-Lupar stream are of great extent. The hilly country commences on the left bank; for instance, on the tributary Lingga, ten miles above the mouth, and on the Batang-Lupar, near the gold-fields of Marup.[2]

The great delta of the Rejang stream is a morass; and the swamps can only be travelled over by boat.

The sea-sand formation—a long and broad strip of sand-dunes—extends from Sarawak, right along the coast, excepting at the river mouths;[3] and the flat-land extends in the basins of the Oyah and Mukah, as far as the Ular-Bolo mountains,[4] while on the Barram stream, the Diluvium is reached at about one hundred nautical miles from the coast.

In the north of Brunei, where the chains of hills often extend right down to the sea, there is no deposition of sand, but where flat-land predominates sand-dunes are formed; for instance, from the mouth of the river Tampassuk to the Enten island, a distance of nine and a-quarter miles.[5]

In the north-eastern parts of Sabah, Alluvium occurs only in the lower river-courses, as, for instance, those of the Labuk and Kinabatangan; elsewhere its formation is, for the greater part, prevented by sand-dunes.

The north coast of Sabah deviates, in many respects, from the north-west coast. The latter presents in general a straight coast line; the former, on the other hand, is deeply indented.

On the north-east coast of Sabah, high mountains rise close to the sea-shore, and hinder the development of water-courses; they die away, however, toward the north-east, giving place to important drainage areas.

---

[1] Crocker N. 34, p. 194.
[2] Ib. N. 34, p. 126.
[3] Ib. N. 34, p. 194.; Boyle N. 11.
[4] Le Monnier N. 40, p. 476.
[5] Ib. p. 531.

On the north-west coast the sea-bottom dips away suddenly; but on the north-east the sea is shallow, and only small depths exist even at great distances from the coast; coral-reefs are also extremely common.[1]

The rivers on the north-west coast of Sabah, have all the characteristics of the rivers on the east coast.[2]

The mouth of the river Kimanis is barred by a long sand-bank, and vessels with a draught of six feet can only pass at high water. The little rivers Ananam and Kabatuan, which empty into the bay of Gaya, are also barred at the mouth, and have a swampy estuary.

The river Mengkabong resembles rather a large salt-lake than a river. It contains numerous islands and extensive sandbanks. At low water tracts of the river-bed are exposed, which are covered at the flood-tide. Its banks are sandy, *i.e.*, a sand-dune impedes the out-flow and dams back the water to form a swamp. About three nautical miles from the coast there is a large, shallow lake, which becomes dry in parts at low water, and in other parts has a depth of only sixty centimetres.[3]

The Tawaran, which is also barred, has fresh water at its mouth. The Sulaman and the remaining small rivers,[4] have the character of a salt-lake. The Tampassuk is also barred at its mouth by a sandbank. These three rivers might be regarded as salt-water lakes with numerous islands.[5]

The Tawaran and the river Tampassuk which flow through a river-plain (more or less broad), as far as the villages Bang or Koung (a distance of twenty to twenty-two miles), are genuine fresh-water rivers. Each divides into two chief arms, and takes its source in the out-skirting hills of Kinabalu.[6]

The Maruda bay (twenty-five miles long and twelve broad) is one of the deepest indentations. The western shore is at

---

[1] Le Monnier N. 40, p, 539.

[2] Ib. p. 527.

[3] Bove N. 20, p. 51.

[4] Le Monnier N. 40, p. 536.

[5] St. John N. 10, p. 223.

[6] Ib. p. 224.

first flat; then come low hills which, at the end of the bay, assume on both shores a mountainous character. The small rivers emptying into the bay, contribute largely to its silting-up.

From the western side of this bay, the coast is flat as far as the mouth of the river Sugut; lines of low hills appearing only occasionally. In the Labuk bay low hills pass gradually into peaked mountain-chains. The main stream is the river Labuk, with one chief and two subsidiary mouths.

The coast remains flat as far as the neighbourhood of Sandakan bay, and the flats extend for a distance of two miles towards the interior. Broad mud-banks lie in front of the river mouth. Thus, in front of the river Sagaliud, lies a bank traversed by a canal nearly twenty metres broad having, at low water, a depth of only one and a-half metres; beyond it, however, the depth soon increases to six metres. Dr. Montano followed it for a short distance in 1880.

Not far from Sandakan bay are the mouths of the mighty river Kinabatangan; they are Balabatang, Trusan Abai, Tudong, and Buangin. On passing the entrance a swampy plain of forty to fifty miles breadth, and twenty miles length, begins. It is traversed by many channels, forming a complex delta, in which one can easily be lost.

Cape Unsang is low, and all the small rivers on the southern coast of the peninsula have bars in front of their mouths.

The mouth of the river Sibuko is silted up.

RECENT CORAL-REEFS.

The distribution of recent coral formations on the island of Borneo is very unequal.[1]

They are completely absent along the whole of the south-western, southern, and eastern coasts, from Pontianak in West Borneo to cape Mankalihat. Thence to the mouth of the Berau stream in the east, and along the north-western coasts of the districts Montrado and Sambas, as well as along the Sarawak to cape Barram, there is little to be found of them.

In the north-eastern point of the island, however, from Sibuko (St. Lucia) bay, in the east, to the bay of Brunei, in the west, *i.e.*, in the Sabah district, we find numerous coral-reefs. " Coral-reefs begin in the north-east, in the neighbourhood of cape Bum-bum; and most of the islands north of cape Unsang, are surrounded by coral-barriers, which are often miles wide. The Sulu sea is full of coral-reefs.[2]

The cause of their wide distribution is to be found, according to Lehnert, in the fact that the sea around the north-easterly point of Borneo is clear and pure, swept by fresh winds, and always being renewed. Corals can, therefore, thrive here; while in the Sunda sea-basin where there are no great ocean currents, the water stagnates.[3]

(For Coral Growth see under Land-formation.)

VOLCANIC PHENOMENA AND EARTHQUAKES.

It is the peculiarity of Borneo, in comparison with neighbouring islands, that both volcanic phenomena and earthquakes, the focus of which should be sought in Borneo itself, are unknown. They seem to be entirely absent.

---

[1] See the maps of Lehnert (B. 42) and of Fr. Hatton (N. 48). The former gives the coral-formations in the Sunda region, the latter the reefs along Sabah.

[2] Lehnert B. 42, p. 54.

[3] Oesterreicher B. 31, p. 222.

At least, volcanoes of the age of the great cones of Java and Sumatra have not yet been discovered; and the natives have no records of eruptions, although such natural phenomena are not easily forgotten.

Only in the case of the mountain Kina-balu (13,698 ft.) was there any uncertainty as to whether it should or should not be regarded as an extinct volcano.

Junghuhn[1] mentions, indeed, this mountain in his list of the volcanoes of the islands of the Indian Archipelago, excepting Java; but, at the same time, remarks that, to judge from the existing drawings, Kina-balu does not appear to be a true cone.

Spenser St. John, who ascended it in 1858, states that its summit consists of syenitic granite,[2] and Bove likewise mentions that it consists of gneiss and granite.[3] Further, the drawings of Kina-balú by St. John, Bove, and Fr. Hatton point to its being a table-mountain, and not a cone.

A small volcano was recently discovered by the mining-engineer, Van Schelle, while prospecting for tin-ore. He was led to its discovery by finding small weathered fragments of a volcanic rock. This is the more interesting, as up to that time no positive proof of the existence of volcanoes in Borneo had been furnished. The small volcano, Melabu by name, is situated in the district of Montrado, to the west of the Bawang mountains, and about sixty-five kilometres from the sea. It has the regular form of a truncated cone; but its flat top no longer shows any traces of a former crater. The height of the volcano, measured from the foot of the cone, is seventy-five metres. The surface of the cone is inclined near the base, at an angle of 15° to 16°, which increases near the flat top to one of 27°. The greatest

---

1 Java II., p. 851.

2 Observations on the north-west coast of Borneo, in the Journal of the Royal Geographical Society, 1862, p. 220.

3 Note di un viaggio a Borneo in: *Cosmos* di Guido Cora, vol. III. p. 292.

horizontal section of the cone is a circle having a radius of 1,050 metres, excepting in the south-east, where it has a still greater lateral extension. Funnel-shaped depressions occur on the western and southern sides; generally they are of small circumference and depth, only one being sixty-four metres deep. This small volcano, estimated by Van Schelle to have a crater of 206 million metres cubic content, lies in the region of the Old Slate-formation of Devonian age, which consist here of thinly cleaved clay slates (phyllites), felsite-schists, and argillaceous sandstones. The latter are traversed, in the immediate neighbourhood of the volcano, by a nearly vertical dyke, one to six metres thick, striking west of north. It consists of an aplite-like rock. The Devonian strata are much faulted, as can be seen at a somewhat greater distance from the volcano; and in places they have been much tilted. These great disturbances are found everywhere in this neighbourhood, and, therefore, preceded the formation of the volcano.

The volcano consists solely of a variety of hornblende-andesite of a grey colour. It produced lava-streams and loose ejectamenta, volcanic sand, lapilli, and bombs varying in size from a nut to a child's head. The lava-streams appear to have played no great *rôle.* They were erupted in part through the sides of the cone. In places bedding and fluxion-structure are to be observed. The fine material is for the most part altered into a highly ferruginous clay. In all probability the volcano was originally of considerable height; and the present flat top resulted from a shattering of the crater. With regard to its age there is nothing to add, as younger sedimentary rocks are absent.

Similar miniature volcanoes are also found in Sumatra.[1] The small (embryonic) volcanoes Gunong Figa, the four basalt volcanoes, Atar, Kulitmanis, Bukit Duwa, and Tanah

---

[1] Verbeek: *Sumatra's Westkust.*" p. 369.

Garam; further, the volcano Batu Beragung (hornblende-andesite-pitchstone) are, according to Verbeek, older than the main mass of the great volcanoes, but probably younger than the Lower Miocene augite-andesites. They must, consequently, be of late Miocene or Pliocene age. The volcano Melabu, in W. Borneo, is probably of the same age.

While earthquakes are of frequent occurrence in most of the islands of the Malay Archipelago, in Borneo, as in Bangka and Billiton, they are remarkably infrequent.

In order to obtain exact data concerning their occurrence, the resident officials were requested to collect information.[1] All that could be obtained from records and from verbal communication of the older inhabitants, or was to be found in newspapers, is mentioned in the following:—

The natives remember best a fall of ashes. According to one informant, this occurred in the year 1815 of our reckoning. According to other accounts, the event took place sixty years ago (counting from the year 1872). These two accounts agree pretty well with one another, and are probably identical, as the estimates of time by the natives are by no means exact. In the year 1815 there was a great eruption of the volcano Tambora, on Sumbawa, a small Sunda island, lying to the south of Borneo, and probably, the fall of ashes was a consequence of this eruption. The fall was observed along the whole of the south coast of Tanah-Laut (where it lasted three days, and was introduced by loud detonations like the discharge of cannon), as far as Sampit, and probably still farther westward, as well as at places twenty to thirty miles in the interior. In Kwala Kapuas and other places it is said to have lasted seven days, and to have covered everything with a thick deposit of ashes. Earthquakes were not observed.

According to an account of some of the natives, slight

---

[1] Bergsma B. 29.

earthquakes are said to have been felt in Tanah-Laut in the years 1844, 1857, and 1862, and similarly in the districts of Batang Alai and Labuan Amas.

More exact details are given of the year 1864. In the night intervening between the 3rd and 4th of January, a noise like the rumbling of artillery was heard for the space of an hour in Bandjermassin, and even as far off as Amunthai. At the same time, as was afterwards heard, an eruption of the volcano Klut took place.

In the year 1866, three earthquakes were felt. On the 30th of September, at 9.30 in the morning, a slight shock was felt in Bandjermassin. On the 4th of October a rather violent shock, lasting four seconds, was felt from west to east, over the greater part of South Borneo, *e.g.* in Barabei, Amunthai, and Kahajan.

On the 27th November, several moderately violent shocks were felt at 8.51 a.m. They lasted for twenty seconds, and proceeded in an east and westerly direction.

On the 18th October, 1868, a violent shock was felt in Kendangan, at 3.55 a.m. It proceeded in a south-west to north-west direction, and lasted two seconds. It was also noticed in Bandjermassin.

Similarly the eruption of Krakatoa, in 1883, was heard in all parts of the island. It resembled the discharge of artillery.

In East Borneo only one earthquake is recorded. On the[1] 30th October, 1857, two shocks were felt towards the evening, travelling from south to north.

In West Borneo the earliest earthquake of which we have any record, was, according to the natives, very slight. It took place in Mampawa (Chinese Districts) in the beginning of this century. Another followed between 1820 and 1830 in Sintang; another about the year 1850 in Bunut; and another between 1850 and 1860 in Sintang and Sambas,

---

[1] E. 10.

being accompanied, at the first-named place, by a movement of the river.

A remarkable subsidence of the ground occurred in Spauk in the year 1850. It had a circumference of 200 metres, and produced a lake having in places a depth of 150 metres. The subsidence was so gradual, that although the place was inhabited, no accident happened, and nothing was lost.[1]

In Sarawak, North Borneo,[2] a violent earthquake, which is still well remembered, took place in the beginning of the century. It was accompanied by a shower of ashes. Are we to consider this as belonging to the same period (1815) as the one in South Borneo, the reckoning of the natives being so very vague?

Slight shocks are, according to native report, not infrequent.

Single shocks were felt in June, 1874, in the district Sadong, and in June, 1875, in the district of Sarawak proper. A double shock was felt in Sarawak proper in July, 1876.

WEATHERING OF THE ROCKS.

The weathering of rocks is doubtless the same in the Tropics as in the Temperate Zone, only much intensified. The work of the geologist is consequently more difficult, as it is seldom that he finds an unaltered rock, except, perhaps, in the river cuttings.

We are in possession of only a few data regarding this phenomenon.

Van Schelle[3] states that the argillaceous sandstone in the river Bojan (W. Borneo) is weathered into clay to a depth of 2·5 metres, and is then indistinguishable in its upper layers from Alluvial clay.

---

[1] W. 31.

[2] Everett N. 24, p. 200.

[3] Jb. v/h M. 1880, II. p. 19 and 28.

During my stay in Muara Teweh (S. Borneo), I endeavoured to ascertain to what depth the shales of that place were weathered. I had to get it dug into to a depth of one and a-half metres, and even then found only a hard clay. Siliceous sandstones and limestones weather to a much smaller depth.

The weathering of the eruptive rocks is also very great, a fact which was impressed upon me during my ascent of the mountain Pararawen, in South Borneo. I found nothing but a completely decomposed rock, of which it was impossible to say what it was; and even from a depth of several feet I only obtained a very altered rock, which I provisionally referred to granite.[1]

A special kind of weathering is met with in the Chinese districts in West Borneo.

This consists in the formation of laterite in the ancient slates of the north-western islands (Chinese districts, and Sarawak).

The particulars of its mode of occurrence in W. Borneo can be obtained from the descriptions given by Everwyn, and Van Schelle, and by comparison with the laterites of Bangka.[2] Everett comes to the same conclusions with regard to Sarawak.[3]

The same subærial products of weathering are found here as in Bangka. It is remarkable that the geological structure of the Chinese districts is exactly the same as in Bangka. In both areas the superficial distribution of the crystalline rocks is small, and the Old Slate-formation is greatly developed. Granitic rocks are intruded through the latter. In both areas there is a complete absence of all younger deposits,[4] with the exception of the Diluvium and Alluvium.

[1] Posewitz S. 51.

[2] See "Lateritebildung in Bangka;" Petermann's *Mittheilungen*, 1887, Heft I. p. 24; also Posewitz W. 73.

[3] Everett N. 23.

[4] Only on the border of the Chinese districts are there Tertiary-formations.

In both areas the rocks are impregnated with ores, the distribution and occurrence of which is the same in each; rich Alluvial deposits occur at the foot and in the immediate neighbourhood of the mountains; only in Bangka, the ore is tin; in Borneo, gold. The same kind of weathering is developed in both areas, consisting, namely, in formations of laterite.

That the formation of laterite is widespread in the Chinese districts, is shown by descriptions emanating from widely separated places: the river Palo, Skadau mountains, Pawang mountains, neighbourhood of Mandor, etc., and both types are developed in these places—namely, granite-laterite and the slate-laterite.

To the east of Mandor[1] granitic rocks occur chiefly at four places (near Salothong, Njitha-Kong, Tjiung-hiung-sam, and Liong-Kong). In most places the granite is completely decomposed to a depth of five metres, and then is not easily distinguishable from weathered shales. The brownish-black mica disappears nearly entirely, so that only the grains of quartz, and a few pale-green particles derived from decomposed hornblende, betray the origin of the rock.

The same kind of weathering is shown by the granite of the Pandan mountains.[2]

On the less steep escarpments the weathered crust of the granite is 1·5 to 3·0 metres thick, and consists mainly of red clay and grains of quartz, together with fragments of less altered granite.

The nature of the weathering in the two districts is thus the same: we have here a granite-laterite similar to the typical occurrence of Bangka.

The slates are altered, for a depth of one to 2·5 metres into a fat clay, and the bedding is only to be made out in the lower portions (Skadau mountains).[3]

---

[1] Jb. v/h M. 1878, II. p. 134. [2] Ib. 1883, I. p. 7.
[3] Ib. 1884, II. p. 226.

At other places, as for example near Melassan,[1] it was altered to a depth of three metres into a fat clay; and borings to a depth of 4·3 metres, were still in the same clay.

To the north-east of the Bawang mountains, the slates are altered into clay; and, even at a depth of 1–2·5 metres have lost all their slaty structure, passing in places into white kaolin.[2] In this rotten mass, which is permeated with water, are found moderately hard nodules, containing oxide of iron ("iron-concretions"). This ancient "slate-formation" is rich in clay-stone and red-ironstone, containing more or less silica, and occurring in strings, veins, and irregular aggregations.[3]

Great blocks of brown-ironstone also occur in the weathered crust of the slate (cellular laterite-blocks).[4]

During an excavation in the weathered crust and rubble, moderately large fragments of dark-brown and blackish brown-ironstone,[5] containing alumina and silica (cellular laterite), were found.

The slates are similarly altered in the Skadau mountains; in one place they are changed into a white argillaceous or kaolin-like mass, containing quartz, much iron-oxide, and some pyrites, or presenting quartz-veins, clay-ironstone, and white china-clay.

The latter is also found in the alluvial deposits, as in Bangka. Van Schelle explains its origin as follows:—"The pyrites is changed by percolating water partly into oxydised iron-ores, and clay-ironstone is formed in the shales."[6]

To the east of Sungei Palo,[7] much metamorphosed blue-greenish grey slates crop out in places. Here and there clay-ironstone and brown-ironstone are found as accessory constituents of the rock.

---

[1] Jb. v/h M. 1885, I. p. 120.
[2] Ib. 1884, II. 270.
[3] Ib. 1884, II. p. 270.
[4] Ib. p. 270.
[5] Ib. p. 269.
[6] Ib. p. 232, 233, 251.
[7] Ib. 1879, II. p. 80.

In the upper basin of the river Sambas, between Siluas and Sidin, clay slates crop out, alternating with Lydian-stone. In the neighbourhood of Pangkalan Batu these are altered (according to Van Schelle, by the solvent action of hot siliceous solutions) into a porous rock tinted red, brown, and yellow, and containing iron, silica, and alumina. The rock is very cellular (cellular laterite). The original bedding is still discernible in places.

The argillaceous ironstones that occur in the whole of Sarawak are occasionally magnetic, and have a metallic fracture; for the most part, however, they have a dull, reddish, argillaceous surface and fracture, and are often cindery, reminding one of the rocks that occur so frequently in Bangka and on the Malay peninsula. In Bangka they have been called ironstone by Horsfield, and lateritic ironstone by Logan.

I have, elsewhere, published an account of the presence of this phenomenon in Borneo.[1]

CONTACT METAMORPHISM BETWEEN THE OLD ERUPTIVE ROCKS AND THE SLATES.

No metamorphism of this kind has received special description; but one often hears of "metamorphic rocks," not only in Borneo, but also on the remaining islands of the Indian Archipelago.

Usually it is assumed that the ordinary clay-slates in the neighbourhood of granite and other eruptive rocks are "metamorphosed" or converted into hornstone. That such changes do occur is a demonstrated fact; it is far from proved that every hornstone or Lydian-stone (Kieselschiefer), even when it does not occur in the immediate neighbourhood of eruptive rocks, is to be regarded as "metamorphic." In many cases, however, this is the assumption that has been

---

[1] Posewitz W. 73.

made in Borneo and other islands by the Indian Mining-Engineers (*e.g.*, Everwyn, Van Schelle, etc.).

In Bangka, especially, I was enabled to convince myself of the incorrectness of these statements. Here every Lydian-stone or quartzite-schist, is regarded as metamorphic. For example, the foot of Saliuta hill consists of granite, which is covered by clay-slates, alternating with quartzites. Now a metamorphism of the beds in the immediate neighbourhood is supposed to have taken place; and the quartzites and Lydian-stone especially, are regarded as metamorphosed. But since the latter are interbedded with normal clay-slates, showing no trace of contact-alteration, although they must necessarily have had the same chance of being altered, since they are just as near the granite, we are justified in doubting that certain beds were selected for metamorphism by the granite, while the neighbouring beds remained unaltered.

Since the clay-slates show their original character, the accompanying Lydian-stones cannot have been altered (for the same metamorphism must have attacked the slates); and their present character must, therefore, be original.

The same is the case with rocks that lie at greater distances from eruptive rocks.

I do not mean to deny that possibly some of these rocks have been metamorphosed; I only wish to guard myself against the fallacy that all Lydian-stones, hornstones, etc., are necessarily metamorphic.

Verbeek, the well-known Indian geologist, writes on this subject as follows:—

"Among the quartzites and quartzite-schists of this formation (ancient 'slate-formation,' as in Borneo), there are granular, finely granular, and compact varieties. Many agree in character with the well-known 'Hornfels' of the Hartz mountains, the origin of which is described here and elsewhere, to the contact-action of the granite on the clay-slates. In Sumatra also crystalline schistose rocks are occasionally found in direct contact with granite; at times, however, not in its immediate neighbourhood and alternating with clay-slates. Whether we are to regard such cases as instances of the metamorphism of clay-slates, or to refer them to an original deposition of crystalline material, is not always to be decided with certainty."[1]

Further, speaking of the hornblende-chlorite-talc-schists:—"Although their occurrence is limited, and they are intimately connected with ordinary clay-slates, it is often uncertain whether they should be regarded as metamorphic clay-slates."

Verbeek then allows that there is some doubt; whereas Everwyn, for instance, regards the schists, whether crystalline or in the form of Lydian-stone as metamorphic.

I have already shown that I cannot subscribe to this view.

LAND-GROWTH IN BORNEO.

With the exception of the north-eastern point of the island, where hilly country of Tertiary age extends to the coast, and the surrounding sea is full of sandbanks and reefs, as is shown on Hatton's map of Sabah, land is being formed more or less in all parts of Borneo.

In the formation of land there are two well-known factors to be considered, viz.:—plants and animals.

Among the former may be mentioned the mangrove woods, which accumulate in the shallow water along the coast. By their air-roots, these plants promote the accumulation of mud, and they rapidly spread and increase by means of their numerous and lengthy fruits, which fall into the mud, and become fixed there. As soon as the marshy ground becomes dry they cease to grow.

Another plant is the nipa-palm, which flourishes principally

[1] "*Sumatra's Westkust,*" p. 154.

on the shore, both in salt and fresh water. Its matted roots serve admirably to retain floating material; and its angular fruits sink easily into the mud.

The rate of the formation of land in the mangrove-marshes has seldom been determined.

Lehnert[1] made some such measurement in north-east Borneo; and, according to him, under favourable circumstances, shallow shore and light currents, the forward movement of the mangrove-woods may amount to more than a hundred metres in forty to forty-five years. He makes the assumption that a mangrove belt of a hundred to one hundred and fifty metres width, cannot have a greater age than the oldest trees growing on this district, from which the increase of the ground, according to the distance from the shore, can be determined.

Recent coral-growths play an important *role* in the formation of land. In consequence of the currents produced by ebb and flow, sand-hills are formed on the coral-fields; and these are always gaining in height. As soon as these sand-hills have raised themselves above the high water level, vegetation sets in.

A fine example of the growth of such coral islands is given by Lehnert.[2]

In 1843, Sir Edward Belcher made some coast-surveys in the bay of Sibuko. On his map, however, there is no record of the extensive reef before the mouth of the Sibuko, nor of the reefs near the Bum-bum islands; they cannot, therefore, have been in existence at this time, since they offered no obstruction to the ships.

Sandy island, a small island, two metres high, covered with luxuriant vegetation, was, at that time, probably, only a sand-hill; hence its name.

In the year 1875, however, these changes had already taken place; *i.e.*, in a period of thirty-two years the corals had been

[1] B. 42, p. 58. [2] B. 42. p. 119.

raised about six metres (*i.e.*, about twenty centimetres annually), and had encroached on an area of three and a-half square miles (geographical).

This formation of land is greatly helped by the deposition of mud at the mouths of the rivers, the shallows there extending far into the sea. The deposition is also protected by the near-lying coral-reefs, as in the bay of Sibuko. If the silting-up is continued, mangrove-woods are formed in the marshes; and these are always encroaching.

The addition of land thus progresses rapidly in the north-east of Borneo, being favoured both by coral-formation and the growth of the mangrove-woods.

The process of land formation can be well seen in Tanah-Laut, near Tabanio. At this place, at a distance of one kilometre from the shore, are the remains of a fort, which, twenty years ago stood on the beach. The spread of new land is hastened by the mud-heaps, produced by the river which flows through the gold-washing districts.[1] It is most rapid at the mouths of the river, but it also takes place along the coast.

On the east coast, the mud-banks extend for eight to ten nautical miles into the sea, and in the bay of Adang the sounding is only five and a-half fathoms, at a distance of five miles from the shore, Even at a distance of six to seven, sometimes even ten, nautical miles, the depth is only ten metres.[2]

Land formation also progresses rapidly on the coast of Sarawak. Although the coast near cape Sirik is exposed to the north-east monsoon, it is so rapid at this place that it excites astonishment, even on the part of the natives. They estimate the annual increase at three *Klafter* (*i.e.*, fifteen to eighteen feet), and an old man mentioned a distance of two English miles as having been formed during his recollection.[3]

---

[1] Posewitz, S. 53. [2] Osterreicher, B. 31. [3] Everett, N. 29, p. 9.

THE GEOLOGICAL EVOLUTION OF BORNEO.

Up to the beginning of the Tertiary period, the configuration of Borneo resembled an extensive archipelago, in which both small island-groups and larger islands were surrounded by the sea.

The larger islands are now represented by the present "Chinese Districts," together with Sarawak, Sukadana, the central mountain-chain of Borneo, the Tanah-Laut mountains, the mountainous part of Pulu-Laut, and, in the north-east, the mighty *massif* of Kina-balu.

The structure of these islands resembled the present geological structure of the Tin-islands; Bangka, Billiton, and the islands of the Riau-Lingga Archipelago.

Crystalline schists played only a subordinate part. The rocks belonged mainly to the "Old Slate-formation" of Devonian age, and, in the northern portion of the island to the Carboniferous.

The stratigraphical position of these strata was disturbed by the eruption of igneous rocks, granites and diorites. The eruption took place partly after the formation of the Devonian, partly in pre-Devonian times. The disturbances are visible in several places.

The grouping of the different island-clusters in this ancient "Borneo Archipelago" indicated, even then, the main features of the later structure. The Tanah-Laut mountains appeared as a narrow island, running north-east and south-west. Parallel with it was the mountainous Pulu-Laut. The continuation of the former islands, in a north-easterly direction, was formed by the Pramassan Alai, and Amandit mountains, all producing the same general type of island.

Further to the north, there extended a broad sea, which lapped round the foot of the central mountain-chain; and a few island peaks elevated themselves above its surface marking the mountain-chain that now forms the boundary between South and East Borneo.

In the south-west was a large archipelago, consisting of numerous small islands (the mountains of Sukadana and the western part of South Borneo);[1] and a series of small islands extended in a north-easterly direction, right up to the central mountains.

The large island, now represented by the "Chinese Districts," has been already mentioned; from it there extended another row of islands as far as the great Kina-balu island in the north-eastern point of Borneo.

It is worthy of note, that nearly all these islands extended in a north-east and south-westerly direction. Can this be explained by Wettstein's theory, that all rock masses are in a condition of uninterrupted movement to the north-west.[2]

This "Borneo Archipelago" existed up to the beginning of the Tertiary period.[3]

Then began a deposition of sedimentary matter in the seas surrounding the islands. The Eocene strata containing the thick coal-beds, were formed, and then disturbed by the eruption of andesite. Further, younger Tertiary beds, containing brown coal, were deposited. The separate islands were now united to a whole, the Tertiary beds being deposited, not only between them, but also as a belt on all sides. The configuration of Borneo was thus brought nearer to its present shape, first acquiring a form similar to that possessed, at the present day, by the neighbouring island, Celebes, and the

---

[1] Von Gaffron says (S. 27):—"One cannot help receiving the impression that a great number of small islands formerly existed in all parts of South-west Borneo, that afterwards became united by the silting-up of the intervening water-passages."

[2] Dr. H. Wettstein: *Die Strömungen des Festen, Flüssingen und Gasförmigen*, 1880.

[3] It is remarkable that there is a strong belief current with the natives that Borneo formerly consisted of several islands (Tobias W. 1. bei Veth W. 17, p. 6).

small island, Halmaheira. Horner was the first to notice this analogy, and Celebes was termed by him an "emaciated Borneo."

At that time there existed in South Borneo, a large gulf, extending in an easterly direction, far into the interior; and the numerous coral-reefs fringing the island were lapped by the sea.

In West Borneo the sea extended as far as Sintang; here it became narrow, in consequence of the out-crop of Tertiary strata, finally widening out into a large lake.

In East Borneo, a similar state of things prevailed: as far as Muara Kaman, there extended an arm of the sea, above which was a large lake.

In the southern part of the east coast the formation of land had largely increased, and isolated chains of hills formed islands and capes, separated from the mainland by narrow and shallow straits. The same was the case with the western parts of North Borneo.[1]

In the beginning of the Diluvial period the gulfs began slowly to give place to dry land; a strip of flat land was formed along the foot of the mountains, and even in parts of the mountainous country itself; and gold, diamonds, and platinum, swept down by running water, were here deposited. The seas became shallower and retreated; and the present period commenced. Numerous and powerful streams cut their way through the yet marshy lowlands, and flowed majestically towards the retiring sea.[2] That the Borneo of the present day is a very youthful country, is shown, among other things,

[1] Even at the present day certain promontories in the marshes, on or near the coast, are called (as in Bangka) capes. For example, in Sambas, on the west coast we have Tandjong (Cape) Gunong, Tandjong Badjau, Tandjong Bangke. (Jb. v/h. M. 1884, II. p. 280). This indicates changes in historical times, as will be seen hereafter.

[2] During my stay in Borneo I was informed that a short time previously a native boat had been found buried in the ground at the margin of a marshy tract near Martapura, seven geographical miles from the coast.

by the fact that many of the valleys possess a marshy character, the fall acquired by the water being insufficient to carry it off. Such marshy valleys are mentioned, for instance, by Grabowsky[1] in the district of Duson Timor.

In unison with these recent changes are the historical traditions of the natives.[2] According to these, the island, many years ago, was very small, the greater part of the land being then covered by the sea: only the peaks of the mountains Pararawen and Bundang (in South Borneo), projected above the surface of the water, and served as dwelling-places for the ancestors of the present race. These mountainous islands were surrounded by thousands of rocks (coral-reefs ?).

About this time a ship, manned with strangers, neared the coast. One part of the crew being filled with fear on account of the numerous rocks, wished to turn back; the other part, spurred on by the treasures supposed to exist on these islands, determined to proceed. A quarrel ensued; which ended in the total annihilation of the crew. The ship, drifting about among the rocks, the plaything of the waves, was driven on to the coast, and, on the retreat of the waters, remained fixed in the dry land, where, in course of time, it became changed into stone, and can to this day be seen as a rocky prominence, near the mouth of the Barito, above the Kampong Tawan. It goes by the name of the Batu Benama (ship-stone).

A similar story exists among the natives (Dyaks) in Sambas.[3] According to this version, a fleet arrived many years ago from the west (China ?), and the ship, with the crew and everything they possessed, were changed into stone, on account of some transgression against the gods of the land.

The belief also exists that, in former times, the sea extended far into the interior of the present land; and there is

---

[1] S. 52, p. 445.

[2] Schwaner S. 16, I. p. 28; followed by me above.

[3] Jb. v/h. M. 1883, II. p. 91.

a similar tradition existing among the natives of North Borneo.

According to their account the Kina-balu mountains extended, many years ago, as far as the coast.[1] And there are numerous traditions among all the races of Sarawak, relative to subsidences in former years.[2]

The natives living on the river Kottaringin (South Borneo), have a tradition to the effect that the island was invaded by a great flood,[3] in which many lost their lives. Only one mountain-peak (Bukit Arai) remained above the surface of the water, and served as a dwelling-place for the few who were in a position to save themselves by boats, until the water, which covered the land for three months, finally retreated, and the ground became dry again.

CAVE-EXPLORATIONS.

As elsewhere, the limestone-hills of Borneo contain numerous caves, of which, however, but few have been visited, and these only in the more frequented neighbourhoods.

The best-known and most-visited cave in South Borneo is the cave of the Gunong Batu-Hapu (*i.e.*, Limestone-hill), in the neighbourhood of Pengaron.[4]

Three Pal (=4,500 metres) distant from the village of Rantau-Budjur, this hill forms a perpendicular limestone-wall nearly 100 metres high. The cave itself, which is 800 metres long, and in the middle part 150 metres wide,[5] is made up of several grottoes, which communicate with one another, and present a multitude of the most beautiful stalactitic formations. This cave is also the one most accessible to travellers.

---

[1] Hatton, N. 48, p. 225.

[2] Everett, N. 29, p. 5.

[3] Schwaner, S. 16, II. p. 151.

[4] De Jongh, S. 35, and Verbeek, S. 41, p. 66.

[5] Measured by the Mining-Engineer, Rant, and by Verbeek, published in Jaarboek, v/h. mynwezen, and in Neues Jahrb., 1875, I, on his Geological map, No. 1.

Other caves have also been discovered in the north-eastern prolongation of the same Tertiary coral-reef: as, for instance, the grotto of Lampinit, with its two floors; the cave of the Gunong Talikor, through which flows an underground river; and the grottoes of Batu-laki and Batu-bini.[1]

Some of the many caves in the limestone district have also been visited, *e.g.*, the Lubong-angin caves by Low,[2] about 200 ells long, 20 to 30 ells wide, and 30 to 50 feet high; the limestone caves of Si Budah (108 ells long), etc. The grotto in the Rumbang hill is mentioned by St. John,[3] so also the Sirih cave, on the river Samarahan, which is one-third of a mile long. The same traveller visited several limestone-caves in the neighbourhood of Langusan, in the basin of the river Barram (Brunei).

Cave explorations have been started in the limestone-district of Sarawak (which are comparatively easily accessible); up to the present, however, without results of any importance.[4]

The earliest investigations were undertaken by a Mining-Engineer named Coulson. They were, however, unsuccessful.

In 1865, some excavations were made under the supervision of O. Beccari, in a limestone cave near the village of Busso (Busau on Crocker's map), on the left tributary of the river Sarawak. "Some human bones, mixed with other bones, shells, and fragments of coal, were found."[5]

The work was continued by Everett,[6] in 1869, who, however, was obliged to desist, on account of illness, before results of any importance had been obtained. In the years 1878 and 1879, he continued the explorations during nine

---

[1] T. J. Grabowsky (Indian Gids. Jan., 1884) In *Das Gold vorkommen in Borneo*, by Dr. Th. Posewitz.

[2] Many recent shells were found here by Low in the clayey floor of the cave. Low, N. I. p. 36.

[3] St. John, N. 9.

[4] A. H. Everett, N. 22, p. 53, and N. 28, 29, 30.

[5] Beccari, N. 12.

[6] Everett, N. 22, 28, 29.

months, but no results of especial importance, either to the geologist or to the anthropologist, were obtained.

Everett's intention, in making these researches, was to see whether the Borneo caves contained Diluvial animal remains, similar to those found in such abundance in the European caves; but more especially to endeavour to discover the ancestors of the anthropoid apes at present living in Borneo, and thence, perhaps, to arrive at a positive or negative result regarding the descent of man.

In all, thirty-two caves were examined, in twelve of which excavations were made; all of these were situated in Sarawak proper, with the exception of two in the Sobis mountains on the river Niah.

Caves containing rich guano-beds are also known in the Gomanton-hills in North Borneo, between the river Kinabatangan and the bay of Sandakan (East-coast residency in Sabah), a large and unexplored cave is situated on the borders of the river Sapugaya (which runs into Sandakan bay). The entrance is 100 feet wide and 250 feet high (Simud hitam= black entrance). At a height of 500 feet is a second entrance (Simud putih=white entrance), which also leads to numerous chambers. The caves appear to be connected by fissures both with one another and with the peak (1,000 feet high).

These caves are interesting, inasmuch as they contain rich deposits of guano—in the upper caves, guano of swallows, 5 feet thick; in the lower cave, the more valuable guano of bats, 50 feet thick.

These deposits constitute a source of revenue for the government, 25,000 pounds being raised annually.

Some of the caves contained guano-beds with bat remains alone. In others, there was a bed of clay, partly pure, partly encrusted with lime, and containing fragments of different rocks.

The clay-beds, which are often at the height of the sea-level, but sometimes over 150 feet above it, are of fluviatile origin, as is proved by the land and fresh-water shells found in them (twenty-five genera and forty species, among which are some new ones).[1]

More distinctly stratified deposits were to be seen in four of the caves:—

1. Of these the highest (up to one foot in thickness) contained remains of articles used by the natives who lived there during the collection of the edible birds'-nests, such as coal, wood, pottery, etc.

2. Then followed a clay-bed, hardened with lime, and containing fragments of limestone—up to fifty feet thick. It contains many recent land-shells and bone-remains, chiefly of small mammals, especially rodentia.

3. A bed, three feet thick, of river mud, and bits of stalagmite mixed with guano and limestone-boulders. It contains numerous fragments of bones of the larger mammals still living in Borneo, which are often worn by transport in water. Further remains of reptiles (chelonians), fishes, bats, large mammals, crustaceans, land and fresh-water snails, etc. Traces of man are of frequent occurrence.

4. Hard clay with sand and boulders, land-shells, and remains of pig (bones and teeth).

The results of the cave explorations shows:—That the deposits are of fluviatile origin, and of recent date, and that the bone-remains are also recent.

It is further remarkable that the caves of Borneo do not contain the same abundance of large mammals, and more especially of carnivorous animals, as those of Europe: usually they only contain small animals, and even these in comparatively small quantity.

With regard to the human bone-remains,[2] these appear to

---

[1] Globus, N. 44.

[2] The following bones were discovered:—Skull (fragments). Humerus (fragments). Clavicula, Os sacrum, Os innominatum, and fragments of the lower extremities.

be of no great antiquity. They belonged to individuals of different ages and both sexes; and presented no points of especial interest, except that they very probably belonged to a Malay type.

The bone-remains were always found at no great distance from the entrance, and scattered about in the upper layers. They were associated with implements, painted and glazed pots, cups, etc.; also, beads, and armlets of a dark blue glass, pieces of iron, worked gold and charcoal.

Similar beads are worn at the present day by the Dyaks. These remains also are, therefore, of very recent date.

It is also remarkable that fragments of pottery, marine and fresh-water shells, burned bones, a drilled tooth of a tiger-cat, and pieces of quartz, were found in the river-mud of a cave. Stone implements were not found.

In the quartz-gravel of a section of the bank of the Simunjan, Everett found a single stone-hatchet of the Neolithic type. It constitutes the only proof of the former existence of a stone-age in Borneo, as at present iron only is used.

III.—USEFUL MINERALS.

GENERALITIES.

In nearly all writings which treat of Borneo, mention is made of the great mineral wealth of the island; and in the oldest works we find nothing else mentioned but the valuable minerals. From the day when the companions of the unfortunate Magellan cast anchor before Brunei, about three hundred years ago, to the beginning of this century, when Hunt handed in to Sir S. Raffles his report "On the Great and Rich Island of Borneo," the wildest ideas have been in circulation with regard to its mineral wealth.

It was believed that as the various districts now became known, more light would be cast on the abundance of useful minerals that were hidden under a thick growth of vegetation.

Time showed, however, that expectations had been raised to too high a pitch, and that, although useful minerals were widely distributed, they existed only too often in quantities that would not pay working.

In the earliest days it was only gold and diamonds which vouched for the richness of the island. Then the coal-beds became known; and antimony and quicksilver were worked (in Sarawak). Mining companies were floated, but their hopes were, in great part, doomed to disappointment.

COAL.

Of the three great Sunda islands—and indeed of all the islands of the Indian Archipelago—Borneo is the richest in coal. The mountain-axis of old crystalline rocks is surrounded by a double belt of coal-seams, which are found in all the river-channels, and in many places on the coast.

The occurrence of coal has long been known to the natives; but since they could not turn it to account, it remained unused for a long time, until found by Europeans, who immediately began testing its value.

Although coal occurs in Borneo in such valuable proportions, it has, up to the present, been comparatively little worked. On the island of Labuan, and near Brunei (in North Borneo), it is mined by Englishmen. The same is the case in Sarawak (North-West Borneo); while in the remainder of the island, with the exceptions of a few small workings on the part of the natives, there exists only a single small mine, which was also the first opened. This is the Oranje-Nassau mine in Pengaron (South Borneo). It has, however, been abandoned for some years.

The particulars of the occurrence of coal in Borneo are treated separately under the head of the several parts of the island.

But before proceeding to them, I will make a few remarks on its general occurrence, as its petrographical and tectonic relations appear, from our present knowledge, to be the same in the different districts; the occurrences only differing in respect to the age of the coal. Schwaner says:—"The occurrence of coal is more widespread than one might be led to think by a first examination. In the whole of the hill-formation it constitutes a most important and almost never-failing factor. All fissures and openings that have been made use of for the investigation of the under-ground geology, have led to the discovery of coal-seams, and even the banks of the great rivers disclose them in many places."[1]

The coal-seams belong, however, to different horizons; still the oldest coal-bearing formation is, according to present

[1] Schwaner S. 16, I. 59.

views, of Eocene age—the sandstone beds—*a* of Verbeek. This coal is well characterized by its stratigraphical relations. There is, further, coal in Oligocene and Miocene strata; and also in the Diluvium and Alluvium.

Already, in 1836, two separated coal-formations were distinguished by Horner,[1] neither of which, however, was older than the Tertiary period, the younger containing brown-coal.

Von Gaffron[2] also mentions the occurrence of brown and black coal in the western parts of South Borneo. These evidently belong to different formations.

Schwaner[3] remarks that the formation of coal-seams falls into different geological periods, of which, however, none are older than the Tertiary. The greatest development and distribution are shown by the older beds, which under the pressure of the superincumbent sandstones, shales, and limestones, have lost all traces of their origin. The higher-lying Diluvial coals, on the other hand, have retained their woody structure. The third period of coal-formation falls in the present time; it goes on in all the places where the vegetable remains, swept away by the rivers, can be deposited together with sand and clay.

EOCENE COAL.

Most of the Borneo coals belong, with the exception of a few brown coals, to the Eocene period—the sandstone beds *a* of Verbeek. They are better known than the remaining coals, as they contain the "Indian pitch-coal,"[4] and they have been sought for in many places on account of their practical value. It is indirectly to these investigations that our knowledge of the widespread occurrence of the formation is to be ascribed.

---

[1] Horner, S. 2, and Müller, S. 22, the old coal-formation is secondary (our Eocene) according to him; the younger Tertiary (our Diluvium), see Horner.

[2] Von. Gaffron, S. 27.

[3] Schwaner S. 16, I. 59.

[4] This good coal is also found on the other islands, in strata of similar age.

With regard to geotectonic relations the coal-bearing strata form a hilly country, and are thereby easily recognisable.

Their petrographical relations have already been discussed in connection with the Tertiary beds.

It is an important fact, from a geological point of view that they are pierced in many places by andesites, resulting occasionally in faulting and shattering of the coal-seams.

With regard to age, it was demonstrated under the discussion of the Eocene, that they probably belong to that period.

South Borneo.

Historical.

The first discovery of coal was made, it appears, by Horner during his journey through a part of the Tanah-Laut district in 1836. This was on the river Karang-intan (riam Kanan).

Some years later, in 1844, coal-seams were again discovered by Schwaner in two places (on the rivers riam Kiwa and Batu-api). These were of importance, inasmuch as they were the first that were worked here, and it was at this place that the whole formation was first submitted to closer examination and study.

In the sixties, an animated discussion arose as to whether the Pengaron coal was "brown coal" or not. Bleekrode, in Holland, described it as such, while the Indian Mining Engineers, C. de Groot, and P. van Dyk, held the opposite view.

It was pronounced to be "brown coal" by the Vienna "Geologische Reichsanstalt," where it was chemically examined;[1] and the same view was held by Frenzel.[2] Hochstetter[3] says—"They are bituminous pitch-coals and brown-coals" (not "black-coals" as has been incorrectly stated), of medium quality. Kloss[4] mentions in favour of the "brown-

[1] C. de Groot, B. 26, p. 69.
[2] Frenzel, B. 38, p. 302.
[3] Hochstetter, B. 10, p. 288.
[4] Kloss, B. 20

coal" view, that on distillation acetic acid is formed, and it is (although only slightly) coloured by treatment with potash. In favour of its being "black coal" is the 72·8 per cent. of carbon. C. de Groot calls it "black coal," as Von Gaffron had already done, and Verbeek[1] gives it the same name. In my opinion, the great diversity in the views expressed is due to the variability of the coal itself, which, in some places, resembles black, in others brown, coal.

The localities were, one near Gunong Batu Bobaris (=Pengaron); the second in the neighbourhood of Gunong Batu api, near Lok-pinong (=Lok-besar).

In the fifties, C. de Groot and Rant traced the continuation of the coal-formation to Karangintan (on the Riam Kanan), and to Banju-irang, twenty-one pal (=about twenty-six kilometres), from the Java sea. The coal outcrops were thus made known throughout an area of over thirty geographical miles.

Distribution of the Eocene Coal.

In S. Borneo the Eocene coal occurs in the hill-land as a belt round the mountain-land, and forms a basin lying open towards the south coast. Its presence has been proved in many river-beds, and this shows that its occurrence is not merely local, but that it forms a connected deposit. We must again remember that our information on this subject in the central and western parts, has not advanced much since the investigations of Schwaner, Horner and Von Gaffron, in the thirties and forties.

The most southern point in the Tanah-Laut district where coal-outcrops are known is near Banju-irang (twenty-six kilometres from the Java sea),[2] and one kilometre south-east of this place, on the Maluka river, there is a coal seam, three feet thick (strike, south-east and north-west, dip 10°).

[1] Verbeek, S. 41, p. 59.
[2] S. 14 Banju-irang, near Kalangan, where the Qulier-Hermina mine was.

The coal, which yields 55·84 per cent. coke, 4·12 per cent. ash, and a little sulphur, is black, with a greasy lustre and conchoidal fracture.

From here the coal-beds extend generally in a north-easterly direction, parallel to the mountain-chain, in an area extending over thirty geographical miles, to the rivers Riam Kanan and Riam Kiwa.

Up to the river Kanan, coal-outcrops are known from the following places:—

(1) Gunong Si-Udjan, between Kalangan and G. Lawak (three seams of 0·75—1·2 metres thickness. Contains pyrites, but can be used).[1] Strike, north and south; dip, to the east.[2]

(2) Near Gunong Bassun, a seam, 1·25 metres thick, 4·0 metres deep. Is vertical, and strikes north-east and south-west. The coal is laminated, contains resin, but is free from iron-pyrites.[3]

(3) At Mt. Mangu-alung, a seam 0·62 metre thick, striking west-south-west and east-north-east; dip, 15°.[3]

(4) In the brook, Danan Krassik, a seam, 0·90 metre thick, striking north-east and south-west; dip, 10°.[3]

On the river Riam-Kanan (=Karang-intang), coal out-crops are seen near G. Djabok and Djalamadi.[4]

Thence the coal-formation extends (as already shown by Rant) to the river Riam Kiwa (=Batu api). It is exposed in the bed of the river S. Takuti, and also near Assahan.

On the river Riam-Kiwa, nineteen coal-seams are known near Pengaron (strike, north-east; dip, 30°–60°); further on the left shore, between Pengaron and Lok-tunggul; near Lok-besar (=Lok-pinong of Schwaner); near Sungei Pinang —a seam 1·0 metre thick (strike, 80°; dip, 30° to the north); near Rantau Bekula a seam of 1·0 metre thick (strike, 25°; dip, 20° to the west); in the tributary Antongin, east of Mt. Tamban, a seam 1·0 metres thick (strike, 345°; dip, 20° to the

[1] Jb. v/h. M. 1884, II. 361.
[2] See Backhaus' map in Jb. v/h. M. 1882, II.
[3] C. de Groot, S. 23.
[4] Verbeek, S. 41.

west.[1] Further to the north, in the district of the Pramassan-Alai mountains, coal-seams are found, presenting, according to Grabowsky, disturbed bedding. Further, in the river Balangan, and close to Tandjong, north of Amunthai. Coal beds also form the rapids of riam Bai on the Sungei Ajo.[2]

Near the boundary with Kutei coal-seams are known in the river Teweh, three days' journey up-stream from its confluence with the Barito; again, coal occurs north of the river Lahay and Topo, three days' journey up the river Limu (a tributary on the right bank of the Barito).

Thick coal-seams occur in the basin of the river Kahajan, namely, near Bereng-Kasintu;[3] further in the Menohing,[3] where they are inclined at a high angle.

Seams of "black-coal" ("pitch-coal") also occur in the basin of the river Katingan on the upper Katingan and Samba. Similarly coal-seams occur on the northern Sampit, and on its tributary, the Kalong;[4] also on the Kottaringin.

The coal forms, as already mentioned, in speaking of the "hill-land," a curved outcrop open towards the Java sea; it extends towards the interior on the river Barito, but approaching the coast in the western river-basins.

Coal in Pengaron.

The best known coal is that of Pengaron.[5] There are nineteen seams here.

---

[1] Geological maps showing the distribution of coal in S. Borneo are given in:—Jb. v/h. M. 1874, II. C. de Groot. Jb. v/h. M. 1875, I Verbeek, and Jb. v/h. M. 1884, II. The "Natural History Commission" had already prepared a "coal map" west of Muray, as far as Martapura, in which Assahan was marked. This locality was forgotten, and rediscovered by Fleury (Jb. v/h. M. 1874, II. p. 42).

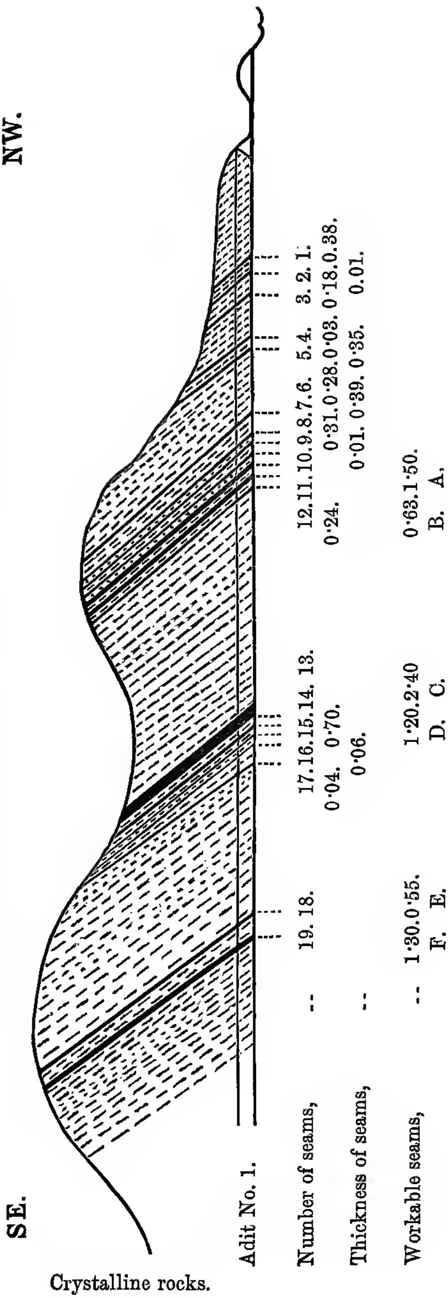
[2] Schwaner, S. 16, I. p. 14.

[3] Ib I. and II.

[4] Von Gaffron, S. 27. Schwaner does not mention coal in the upper Katingan, but he was prevented from seeing the river sections by the high state of the water.

[5] Schwaner had already proved the presence of three coal-seams near the Gunong Bobaris, probably the seams C, B, A. The deepest and largest (8 feet = 2·40 metres) has a fine coal, but little pyrites, and a parting of shales and clay-ironstone 0·80 metres.

SECTION OF THE COAL SEAMS IN PENGARON—ADIT NO. 1. (C. DE GROOT.)



These are best exposed in the level N. 1 (since fallen in).[1] The succession is as follows:—

	Metres.
Variegated sandstone with partings of white clay, ..	0·70
Hard clay with nodules of clay-ironstone, ...	0·02
Blue shale with small seams of sand, ...	1·15
Red sandstone with partings of blue clay, ...	0·08
Blue plastic clay, ...	0·53
Coarse sandstone with nodules of clay-ironstone, ..	0·10
White plastic clay, ...	0·11
Bed of clay-ironstone, ...	0·01
Coarse yellow sandstone with clay partings, ...	0·70
Blue clay with sandy stripes, ...	0·18
Red sandstone, ...	0·03
Blue clay with sandy stripes, ...	1·40
Blue plastic clay, ...	0·06
Loose yellow sandstone, ...	0·06
Blue clay with sandy stripes, ...	0·17
Grey sandstone, ...	0·08
Blue shale, ...	1·43
Blue micaceous sandstone, ...	1·48
Compact grey clay with nodules of clay-ironstone, ..	3·85
Grey micaceous sandstone, ...	0·35
Blue compact shale, ...	0·70
Loose yellow sandstone, ...	1·09
Variegated sandstone with clay stripes, ...	0·70
Grey compact clay with nodules of clay-ironstone, ..	5·50
Grey clay with sandy stripes, ...	2·63
Grey clay with layers of clay-ironstone, ...	2·45
Coal, ...	**0·38**
Carbonaceous shale, ...	0·18
Grey compact clay with sandy stripes, ...	2·10
Grey compact clay with nodules of clay-ironstone, ..	3·33
Sandy shale, ...	0·20
Carbonaceous shale, ...	0·01
Light grey sandstone, ...	0·51
Coal, ...	**0·01**
White sandstone, partly coloured red, ...	1·44
Grey sandstone, ...	0·88
Grey clay with nodules of clay-ironstone, ...	3·11
Same with sandy layers, ...	1·05
Coal, ...	**0·18**
Grey clay, ...	0·88
Grey sandstone	0·07
Grey clay, ...	0·27

[1] C. de Groot, S. 23 ; Von Gaffron, S. 17 ; and Rant S 19.

	Metres.
Bed of clay-ironstone, -- -- --	0·01
Light grey sandstone, -- -- --	0·21
Grey clay with nodules of grey ironstone, -- --	1·23
Carbonaceous shale, -- -- --	0·13
Carbonaceous shale with a seam of coal 0·05 metres thick, --	0·95
Solid clay, -- -- --	1·29
Light grey plastic clay, -- -- --	0·42
Bed of clay-ironstone, -- -- --	0·01
Yellow sandstone with layers of clay, -- --	0·31
Grey micaceous sandstone, -- -- --	0·53
Bed of clay ironstone, -- -- --	0·04
Grey clay with layers of sand, -- -- --	4·20
Loose white sandstone, -- -- --	0·13
Grey clay with a little coal, -- -- --	1·26
Brown clay, -- -- --	0·35
Coal, -- -- --	**0·03**
Grey Clay, -- -- --	0·10
Coal, -- -- --	**0·35**
Compact clay with nodules of clay-ironstone, -- --	2·59
Same mixed with coal, -- -- --	3·50
Grey sandstone, -- -- --	1·75
Compact clay with nodules of clay-ironstone, -- --	4·20
Brownish grey clay, -- -- --	0·88
Coal, -- -- --	**0·28**
Grey clay with layers of sand, -- -- --	1·40
Clay mixed with coal, -- -- --	0·07
Grey clay with nodules of clay-ironstone, -- --	2·63
Coal, -- -- --	**0·39**
Carbonaceous shale, -- -- --	0·35
Grey clay. -- -- --	0·25
Coal, laminated, -- -- --	**0·31**
Carbonaceous shale, -- -- --	0·53
Grey clay, -- -- --	0·70
Grey hard sandstone, -- -- --	0·35
Grey sandstone with nodules of clay-ironstone, --	0·53
Coal, -- -- --	**0·01**
Carbonaceous shale, -- -- --	1·40
Bed of clay-ironstone, -- -- --	0·04
Grey sandstone, -- -- --	0·18
Grey clay with nodules of clay-ironstone, -- --	0·28
Carbonaceous shale with fossils, -- -- --	0·70
Coal-seam A, first half, -- -- --	**0·53**
Grey clay -- -- --	1·23
Coal-seam A, second half, -- -- --	**0·97**
Grey shale, -- -- --	0·70
Coal-seam B, with carbonaceous shale 0·2 metres, --	**0·63**
Grey clay with nodules of clay-ironstone, -- --	1·93
Grey sandstone with two beds of clay, -- --	0·29

	Metres.
Greyish-blue shale,	0·70
Coal,	**0·24**
Grey clay with coal,	0·53
Grey clay with nodules of clay-ironstone,	2·80
Grey clay with layers of sandstone,	1·68
Hard yellow sandstone,	0·18
Grey argillaceous sandstone,	1·82
Grey clay with layers of sand,	0·12
Loose white sandstone,	0·14
Grey clay with sand and coal,	0·14
Yellow sandstone with clay,	0·20
Bluish-grey shale with sand,	0·42
White sandstone,	0·60
White plastic clay,	0·04
Bluish-grey shale with sand,	0·35
Yellowish sandstone with clay,	1·34
Bluish-grey clay with sand,	0·70
Brownish-grey clay with sand,	4·23
Grey clay with sand,	0·35
White sandstone with clay and clay-ironstone,	3·15
Brownish-grey clay with sand,	3·50
Fine grey shale,	1·27
Coal-seam C,	**2·40**
Brownish-grey clay,	1·18
Coal-seam D,	**1·20**
Brownish-grey clay and nodules of clay-ironstone,	1·40
Coal,	**0·70**
Brownish-grey shale,	0·18
Coal,	**0·06**
Brownish-grey clay with nodules of clay-ironstone,	1·68
Laminated Coal,	**0·04**
Grey clay with nodules of clay-ironstone,	0·98
Greyish-yellow sandstone with clay,	10·09
Light-grey sandstone,	0·31
Bed of clay ironstone,	0·10
Brownish-grey clay with nodules of clay-ironstone,	0·70
White sandstone,	1·80
Yellow sandstone,	0·25
White sandstone,	0·18
Brownish-grey clay with nodules of clay-ironstone,	0·35
Grey sandstone with clay ironstone,	0·88
Brownish-grey clay with nodules of clay-ironstone,	1·40
Grey sandstone with clay,	1·23
Brownish-grey clay with nodules of clay-ironstone,	1·93
Carbonaceous shale,	1·40
Grey plastic clay,	0·35
Grey shale,	0·29
Grey shale with coal,	0·08

	Metres.
Carbonaceous shale with nodules of clay-ironstone, ..	1·75
Coal-seam E, ...	**0·55**
Grey clay with clay-ironstone and leaf impressions, ..	0·70
Grey clay with nodules of clay-ironstone, ...	0·35
Compact light-coloured sandstone (yellow), ...	0·53
Compact light-coloured sandstone (white), ...	1·40
Carbonaceous shale, ...	3·08
Coal-seam F, ...	**1·30**
Brownish-grey clay, ...	3·15
Grey sandstone with clay, ...	3·50
White sandstone with red markings, ...	7·29
Brownish-black shale, ...	0·70
Total thickness, metres, ...	159·70

The thickness of the nineteen coal-seams is 10·66 metres.[1]
" sandstone beds, 43·54 "
" clay beds, 105·70 "

The beds strike north-east parallel to the mountain-chains, and dip 35° to 50° to the north-west, but they are faulted in places.

The coal is compact, black, with greasy lustre and conchoidal fracture; it gives a brownish-black powder. In places it shows a woody structure, and is then brown, and imparts a light brown colour to potash solution; otherwise the potash remains uncoloured.[2] All the coal-seams contain pyrites. The percentage of sulphur is one-third. In greater or smaller quantity there is always present a yellow to brownish-yellow resin, soluble in alcohol.

On the Riam Kiwa, twenty-four kilometres above Pengaron, near Lok-pinong, not far from the mouth of the brook Hatuang,[3] Schwaner[4] found five coal outcrops of 5, 2·4, ·7, 2·6 and 3 metres thickness respectively. They are separated by shales containing nodules of clay-ironstone. The strike is north-east; dip, 60° to 75° to the north-west. The

[1] Verbeek S. 41, p. 51.

[2] See controversy on the nomenclature.

[3] On C. de Groot's map (S. 23) the place is simply called "riam;" on Verbeek's map (Jb. v/h. M. 1875 I.) Lok-besar and the brook Halinan.

[4] Schwaner S. 21.

bedding is disturbed by intrusions of diorite. The coal from the first two seams agrees in all its properties with the Pengaron coal. It is dull, black, and has a conchoidal fracture; it contains no pyrites, but has a yellow resin. The streak is a light brown. Occasionally it shows woody structure, and is then brownish-black.

This coal, yielding 60·54 per cent. of coke, 14·05 per cent. of ash and tar, is described as "sand coal" by Schwaner. It is suitable for boiler fuel.

This locality is remarkable, as it was here that the first coal mine was opened (see Mining Ventures).

Similarly Schwaner found six coal seams near the Gunong Garum (Batu Belian), on the river Riam Kiwa.[1]

The strike of the coal seams is north-east by east, dip 50° to 60° to the north north-west. The stratigraphical relations are the same as in riam, so also is the coal; it is also more easily transported on account of the shorter distance.[2]

Coal Seams near Gunong Djabok and Djalamadi on the River Riam Kanan.[3]

Seven coal outcrops were proved in the Gunong Djabok, within a distance of two kilometres. Among them four were workable, three being 1·0 metre in thickness, and one 1·30 metres.

In the Gunong Djalamadi the outcrop of the coal can only be followed for a distance 1,200 metres. The three seams (respectively 1·30 metres, 0·80 metre, and 0·60 metre in thickness), possess a total thickness of 2·70 metres.

---

[1] Crookewit S. 13. The name Batu Belian (= Balahang) is found on C. de Groot's map, but not on Verbeek's. The first-named was prepared before, the latter after, the insurrection of 1859. Hence the difference.

[2] To judge from the topographical description, this G. Garum must lie in close proximity to Pengaron. Perhaps they are the same coal seams; for Schwaner, who never used the name Pengaron, gives the preference (S. 21) to these coal beds over the more recent coal seams further down stream.

[3] P. van Dyk S. 45.

The strike of these beds is north-east and south-west; dip, 12° to north-west.

It has been shown by borings, carried out under the direction of the Engineer Rant in 1855–1859 (the deepest reaching 101·11 metres), that the three seams in the Gunong Djalamadi behave differently underground to what they do above the surface. The first, seam A, 0·80 metre thick at the surface, thins out downwards to a thickness of 0·50 metre; seam B, which is 0·60 metre at the surface, splits up into two bands with intermediate beds; and seam C thins out similarly.

Rant assumes the existence of a fault, as there was a difference of seventeen metres in the position of seam C in the first two borings.

According to Hooze's latest researches, however, it is not a simple fault, but a saddle-like elevation of the beds in consequence of the intrusion of andesite.[1] According to him the coal beds of Djalamadi are probably the same as those of Djabok.

West Borneo.

Up to the end of the forties all that was known, with regard to the occurrence of coal in W. Borneo, was that it occurred near Salimbau, on the river Mentiba (tributary of the Bunut) near Blitang, and on the lower Melawi.

In the two first localities coal was dug by the natives in 1847 and 1850: it was tried on steamers and found to be good.[2]

After this investigation a small mine was to have been opened there; but the scheme fell through, as the native ruler took the coal supply into his own hands.[3]

The mining-engineer, Everwyn, was the first who prospected for coal in W. Borneo. According to his investigations the

---

[1] Javaverslag 1884, II. [2] Everwyn W. 39, and W. 8.
[3] C. de Groot B. 22.

Eocene coal forms a basin in the district of the river Kapuas open to the sea on the west. This basin begins above Bunut, narrows near Sintang, but widens again farther down stream, terminating in the neighbourhood of Spauk.

In the basin of the upper Kapuas coal is said to occur above Bunut, on the river Ambalu, and, perhaps, on the Kapuas itself.

Coal-seams occur on the tributaries of the Bunut, the Bojan and Selibit (Mentibah). On the latter river the coal seam is 1·0 metre thick, and inclined at a low angle towards the north. In the river Bojan, seams of good coal occur, having a thickness of 0·3 and 0·6 metre, and slightly inclined towards the north. Near Napan, on the same river, coal of 0·20 to 0·45 metre thickness occurs. The strike varies. Usually it is south-west and north-east; also north by east, and south by west. The dip is 7½° towards north-west. Near Nanga-Riet only carbonaceous shale occurs. These beds have a strike of south-west and north-east; they dip at a low angle, towards the north-west. In a second place, they strike west-south-west and east-north-east, and dip at a low angle towards the south-east. Coal is also said to occur in the Djonkong (Embuan) river-valley, but it was only found in fragments.

It would appear that we have here to do with a small coal-trough, in which the thickness of the coal varies considerably.[1] Near Salimbau the coal-beds are horizontal. At a depth of 1·0 metre, a coal-seam, 0·3 metre thick, was found, and coal is said to have been found formerly at a depth varying from four to six metres. In the tributary Ringan, a horizontal bed of 0·9 metre thickness occurs, and fragments of coal were also found in the tributary brooks. In the basin of the upper Labojan, there is no coal; but it occurs in the river Kniepei, a tributary of the Tawan, south of lake Seriang. It also occurs further to the north and south.[2]

---

[1] Van Schelle, W. 51. [2] Jb. v/h. M. 1880, II.

Thin coal-seams occur in the river Katingan, similarly in the hills Tungul and Lilin (bedded horizontally). A seam, 0·3 metre thick, was found in the river Silat, near Sintang, at a depth of twelve metres. This was very good coal, with a dip of 20° towards the north-east. Fragments of coal were also found in the river channels.

A seam of laminated coal, 0·75 metre thick, having a slight dip to the east, was found in the river Tampunah; further, in the river Blintang. Below Sangau, on the Kapuas, a seam 0·2 metre thick, was found below a gold-mine. The coal was lustrous, black and pure.[1]

In the basin of the river Melawi, coal is only known in the neighbourhood of Pinoh. (Near Sintang, 0·03 metre thick, with horizontal bedding; near Pinoh, 0·04 metre thick.) Similarly coal is said to occur in the tributary Kajan. Whether coal also occurs in the upper basins of the rivers Melawi and Pinoh, is at present unknown.

Coal is not known in other places in W. Borneo, neither in Sukadana, nor in the Chinese Districts.

The value of the coal-beds, for working purposes, has not yet been proved. This can only be decided by detailed boring investigations.

East Borneo.

Historical.

The earliest information regarding the occurrences of coal in E. Borneo, was given near the end of the forties.[2]

Coal was first discovered in 1845 or 1846, above Samarinda, in the river Mahakkam (Kutei). It was tested, without delay, and found to be suitable for smithy coal. In consequence of this, Von Dewall, the then civil official in E. Borneo, was commissioned to examine the coal-beds.

In 1847, he found coal-seams in four rivers (Karang-assem-

---

[1] Everwyn, W. 39, p. 38. [2] C. de Groot, S. 23.

Ketjil, Karbomo, Sanga-sanga and Dondang), in the neighbourhood of Samarinda, and similarly on the hill Pelarang. Coal was also reported to occur up-stream, near Tengarong, and also six days' journey above Tengarong, near Karta. The coal of Pelarang, and from the river Karang-assem-Ketjil, was tested, and found to be suitable for boiler fuel, although it burnt more quickly than English coal.

On the ground of these results the Indian Mining-Engineer, C. de Groot, was sent to Kutei in 1852, in order to investigate the coal-beds more closely. He substantiated Von Dewall's report, and found the coal-seam near Pelarang suitable for working. Consequently, it was determined to open a coal-mine here. (See Mining Ventures).

Coal was discovered in 1848 near Gunong Tabor, on the river Berau.[1] It was of good quality, and was furnished by the natives to passing ships.

It was not till 1881, that a mining-engineer was sent there to examine the coal-beds more closely. Coal was wanted to replace that of the mine in Pengaron, which it had been decided to close.[2]

In 1851 coal was discovered on the island of Tarakan, near the mouth of the river Sibawang. (State Tidung.)[3]

The occurrence of coal in the island of Laut, was already known in the year 1850. In 1852 it was examined by C. de Groot, who, however, found the coal unsuitable for working, and this was substantiated by later investigations in 1880.[4]

Island of Laut.

Coal-beds occur on the north-west coast of the island of (Pulu) Laut; but they are much disturbed by intrusions of andesite and dip towards the sea.

---

[1] Hageman, E. 7, Von Dewall, E. 6.
[2] Jb. 1883, II. 142.
[3] Hageman, E. 7, Von Dewall, E. 6
[4] Jb. 1884, II. 239.

The following section of these beds, near Cape Pamantjingan, is given by C. de Groot:—[1]

	Metres.
Shale,	1·22
Coal sandstone,	0·20
Coal,	**0·025**
Shale (in part ferruginous),	1·62
Coal,	**0·46**
Sandy shale,	0·57
Argillaceous sandstones,	0·56
Shale (in part ferruginous),	2·07
Coal sandstones,	1·80
Shale (in part ferruginous),	0·73
Do. (ferruginous with coal),	0·25
Do. (in part conglomeratic),	3·70
Do.	0·42
Coal,	**2·00**
Sandstone,	

The coal in the last seam is of good quality. But it cannot be exploited on account of the presence of faults, and of the dip being towards the sea.

Coal-beds dipping towards the sea also occur on the island of Suwangi.[1]

The coal-formation of the island of Laut, which is also assigned by Hooze to the Eocene period, is continued over the island of Suwangi (as already mentioned), the islands of Nangka, Tandjong Dewa, Tandjong Batu, as far as the bay of Klumpang. The coal is not worth working in these places on account of its small extent and unfavourable position in respect of transport facilities.[2] Two coal-seams also occur in the bay of Pamukan (Tanah-Bumbu), on the right bank of the estuary of the Sampanahan. They occur in the quartz-sandstone of the G. Batu, and possess a thickness of 1·10 and 1·75 metres respectively, and are interbedded with clay slate. The upper seam contains much pyrites, resin and clay-ironstone; the lower seam is purer, and resembles the Pengaron coal.

---

[1] C. de Groot, S. 23, p. 66. [2] Javaverslag, 1886, I.

The coal-formation dip towards the north-west. In the south it is almost vertical, and towards the north has a dip of only 10° to 12°. Andesites are found in the neighbourhood.

Although this coal is only 2–500 metres from the coast, the coal-field is of no great extent, owing to its proximity to the "mountain-formation." It is probable, but not proved, that the coal which is said to occur three days' journey up the river Batu litjin, is Eocene.[1]

According to the latest investigations of Hooze, the Eocene formation does not occur on or in the neighbourhood of the coast further to the north. But it appears to be contained further inland; for Von Dewall mentions the occurrence of seven coal-seams in the interior of Passir, on the eastern foot of the Lumbang mountains, near the place Bussui. The seams crop out in the river channel, and the coal is said to be of good quality.[2] Altogether, very little is known about the coal-wealth of Passir.[3]

With regard to the further distribution of Eocene coal in Kutei, we have no definite information. Probably it also forms here a basin, open towards the coast, as in S. Borneo, and possibly the above-mentioned coal-beds near Karta (six days' journey above Tengaron), are part of the same series. With regard to the states Berau and Bulongan, we know nothing. Perhaps the coal which is said to occur two days' journey up the river Sungei Samarattan, is of Eocene age.[4]

North Borneo.

Eocene Beds.

Coal was discovered in N. Borneo by Burns[5] in the year 1848, and mention is made of coal in the interior of Brunei, by Low,[6] in the same decade.[7]

---

1 Verbeek S. 41, p. 115.
2 Weddik E. 3.
3 Nieuw Ruyk E. 12.
4 Hooze E. 13.
5 Burns N. 3.
6 Low N. 1.
7 The first-mentioned seam occurs on the island of Chermin, at the mouth of the river Brunei.

The coal-beds extend along the coast from Sarawak to Brunei. Thence they are continued, either along the coast, or on the neighbouring islands. They are known to occur at the following places:—a large coal-field, with good coal, in Sarawak, eighteen miles from the mouth of the river Linga, a tributary on the left bank of the Batang Lupar. Up to 1881, it was not being worked, as the construction of a railway, eighteen miles long, was necessary, in order to bring the coal to the river Batang Lupar, where it could be shipped.

Very good coal also occurs not far from the junction of the river Simunjan with the Sadong. This has been worked by the Government since 1881.[1]

Coal seams are also present in the neighbourhood of the rivers Rejang, Mukah, Bintuluh, and their tributaries.[2]

The coal-fields on the rivers Rejang and Mukah are of considerable extent, and contain good coal; on account of their inaccessibility, however, they are not workable.[3]

In Brunei coal is known to occur on the rivers Barram and Limbang (its tributary Madalam.).[4] In the neighbourhood of the town of Brunei itself is the Muara coal-field, in which five seams (of twenty-six, twenty-four, six, five, and four feet thickness), are worked. These supply N. Borneo with coal.[5] Coal is also known on the island of Labuan[6] and Gaya;[7] and it probably occurs also south-west of Kina-balu.[8]

In Sabah coal is known to occur in the bays of Marudu[9] and Sandakan;[10] further, on the river Kinabatangan, far in the interior,[10] near Pinugah, and on the river Quarmote (right tributary of this stream). Hatton, in looking for petroleum on the river Seguati, came across a resinous coal, similar to that of Labuan.[11]

---

[1] Crocker N. 16, p. 195 and 197.
[2] Bellot N. 2, and St. John N. 9.
[3] Everett N. 23, p. 27.
[4] Bellot N. 2, and St. John N. 9.
[5] Gueritz N. 21, p. 329.
[6] Motley N. 7.
[7] St. John N. 9.
[8] Motley N. 7.
[9] St. John N. 9.
[10] Hatton N. 48.
[11] Hatton N. 48.

Coal also occurs about twenty-five miles north-north-east of Labuan, on the coast, near Batu-Batu. It is said to occur in thick seams, and to be of good quality,[1] especially on the river Benkoka, which flows into the sea on the eastern side.[2] In Padas Bay (or Batu-Batu bay), belonging to the bay of Brunei, is an excellent coal. It occurs at the mouth of the river Lenkongan, which empties there.[3]

Exact details are only forthcoming with regard to the coal of Labuan.

Here the coal-seams are found in two ranges of sandstone hills, 300 feet in height, which traverse the length of the island in a north-east by easterly direction. Their direction is, however, subject to change, for near Cape Kulong the dip is 24° to the north-north-west, while at the western end of the island it is 70°.

According to Motley, the following is the section of the coal-beds at cape Kubong:—[4]

	Feet.
Blue shale with fragments of shell (indeterminate),	—
Quartzose conglomerate and coal, red sandstone,	3·0
Sandstone,	12·0
Sandstone, with quartz-pebbles and particles of coal,	4·0
Sandstone and blue shales (plant-bearing), with particles of coal,	21·0
Hard red sandstone,	1·61
Hard white sandstone,	9·60
Quartzose conglomerate and coal cemented by a white sandstone,	30·0
Blue clay,	1·6
Carbonaceous earth,	0·6
Sandstone of various kinds,	47·0
White clay,	0·2
Soft white sandstone,	4·6
Hard blue clay with clay-ironstone,	3·6
Hard blue sandstone,	0·6

[1] *B. N. B. Herald*, 1887, No. 7, p. 170.

[2] Le Monnier N. 40, p. 541.

[3] Peltzer N. 33, p. 384, and *Handbook of Brit. North Borneo*, No. 49.

[4] Motley N. 7.

	Feet.
Sandy laminated clay, -- -- --	1·10
Blue clay, without bedding, disintegrating, -- --	3·30
Carbonaceous laminated clay, -- -- --	0·3
Compact coal, -- -- --	**0·4**
Carbonaceous shales with clay-ironstone, -- --	3·0
Coal (chief seam), -- -- --	**11·0**
Hard carbonaceous shales -- -- --	3·0
Blue well-bedded shales with clay-ironstone and plant remains (palms, dicotyledons), -- -- --	60·0
Coal, -- -- --	**1·6**
Blue shales with clay-ironstone, -- -- --	50·0
Coal, -- -- --	**1·2**
Blue shales, -- -- --	0·6
Sandstone, -- -- --	0·6

Motley thinks that the Labuan coal-field probably extended to the foot of Kina-balu. The coal-beds constitute, according to him, a littoral formation; and he assumes the former existence of a river which flowed from the Asiatic continent, and emptied into the ocean at this spot.

The coal itself is of good quality: it is hard, compact, of conchoidal fracture, and contains a yellow transparent resin, which is used by the natives as torches, like the coal-resin in the river Bintulu.

The Labuan coal contains, according to an analysis of John Percy:—[1]

C -- -- -- --	72·27
H -- -- -- --	5·20
O and N -- -- --	14·28
S -- -- -- --	0·30
Ash -- -- -- --	1·85
Hygroscopic water, -- -- --	6·10
	100·00

(On the Age of the Coal see the Age of the Hill-land in North Borneo.)
(On the Working of the Mines, see Mining Investigations.

Tennison Woods has other opinions as to the age of the coal in North Borneo.[2]

[1] Verbeek S. 41, p. 116. [2] Tennison Woods N. 19.

He holds the Labuan coal for Mesozoic (*i.e.*, Oölitic); the Muara-Brunei coal reminds him very much of the older Australian coal on the river Hunter. According to him it is probably of Palæozoic age.

The age of the Sarawak coal is held by him to lie between the Palæozoic and the Trias. Fossils occur in the strata containing the coal seams, among which he found well-known Australian and Indian forms, as, *e.g.*, *Phyllothea australis*, and *Vertebraria*. These fossils are characteristic of the Newcastle coal.

The correctness of these opinions remains to be tested by further investigation.

MIOCENE COAL.

With regard to their geotectonic relation the strata that contain the more recent coal always form low ranges of hills, constituting the out-lying chains of the "mountain-land" near its junction with the Diluvium.

Petrographical details are only known for a few places.

With respect to their age, we only know that they are younger than the Eocene. The coal itself is a true brown coal.

SOUTH BORNEO.

Distribution.

The Miocene coal appears to have a pretty wide distribution, and, like the Eocene "black coal," forms a basin, open towards the sea. On the western side it extends in an east-north-easterly direction, from cape Sambar (S.W.), crops out on the east of Assem Kumbang, on the river Kahajan, and reaches the Gunong Rantau on the river Barito.

It is remarkable that in the western river basins it is nearly always associated with beds of gypsum, the latter having up to the present been found in no other place.

In Tanah-Laut three coal-seams of a metre thickness occur near Sibuhur,[1] in a quartzose sandstone (resting on diabase). The strike is east by south, and west by north; dip, south by east.

The coal contains 21·4 per cent. of water.

Similar coal is also found near Sungei Assem-assem,[2] as was shown by Rant in the beginning of the fifties. The coal-bearing beds occur in a hilly country, three days' journey from the mouth. They consist of micaceous sandstones and bluish shales, in part containing layers of clay-ironstone. The strike of the beds is east and west; the dip, 45° to the south.

The number of the seams is twelve. Their respective thickness: 0·2, 1·4, 1·5, 0·31, 3·0, 10·0, 1·0, 0·5, 1·0, 0·5, 0·5 metres. The total thickness is twenty metres; the horizontal extent of the twelve seams is 420 metres.

Rant regarded the coal as brown coal, with a brownish red streak, in part possessing woody structure, with conchoidal fracture and slight lustre. The coal contains eighteen to to twenty-four per cent. of water. (For analysis see Coal-Analyses.)

In the district Duson Timor, brown coal beds, having similar geological relations, are seen in many brooks. Violet-coloured shales, with leaf-impressions, and containing a coal-seam only four inches in thickness, underlie a bed of sandy clay, three feet in thickness, and a gold-bearing quartz-gravel (Diluvium), five to six feet in thickness. The coal is very resinous. It is underlaid by carbonaceous shale, nine inches in thickness, which itself rests on a greyish clay of unknown thickness. The strata strike north-east and south-west, and dip 15° to 20°.[3]

Brown coal, up to twenty-three inches in thickness, occurs below the Diluvial gravel on the river Kapuas, above the mouth of the river Kawatan, 1°20′ south latitude. It is underlaid by a plastic clay (weathered shale), and this rests on

[1] Javaverslag 84 I. and II. [2] Rant S. 19.
[3] Schwaner S. 16, I. p. 91 and 95.

a grey fissured limestone. (Stage IV Eocene of Verbeek ?)[1]

Brown coal occurs frequently in the sections of the rivers Kahajan and Katingan, near the "hill-land." These coal-seams always underlie the Diluvial gravels. (River Rungan near Kotta Bukit; river Menohing near Tumbang Danau paken; river Kahajan near Passa Tegara, and Tandjong Bukit Buking; and river Katingan near Penta Tapang).[2]

In the district Katingan traces of coal and gypsum are found wherever Tertiary strata occur.[3]

Recent brown coal is also found in the river sections on the Sampit, below its junction with the Kwajan. Lignite also occurs on the tributary Kalong, and not far from the sea-coast.[4]

In the district Pembuang brown coal extends from the place of the same name to cape Kalap, and along the sea-coast as far as cape Pandaran. Here it is associated with gypsum.

The whole of the southern part of the district Kottaringin contains brown coal and gypsum.

The lignites, alternating with sandy layers, extend from cape Pangudjen, near the river Telok-Kuwei, to cape Silawak. Near cape Silaka there are seven beds of white gypsum, 0·1 to 0·4 inches thick.

West Borneo.

The Miocene coal in W. Borneo follows on the Eocene Kapuas coal-basin, and from Spauk to Tajan forms a basin open to the west, being overlaid in the last-named place by Alluvial formations.

Everwyn mentions the following beds, which, however, have no great thickness:—[5]

---

[1] Schwaner, S. 16, I., p. 150, 151.

[2] Ib. II. pp. 32, 56, 65, 86, 88, 95, 96, 116.

[3] Von Gaffron, S. 27.

[4] Michielsen, S. 46.

[5] Everwyn W. 39, p. 36 37.

A thin seam of brown coal occurs in the hill-chain Lawan-Kwari, which consists chiefly of sandstone, between the places Skadau and Sangau. Similarly beds of brown coal, accompanied by shales and carbonaceous sandstones, occur in the hill-range Betong, and the same is the case near Biang. Seams of brown coal also occur further down-stream in the neighbourhood of the mountain range Tjempedeh, and similarly on the right bank of the Kapuas, near Passtyuran-hadjie.

All these are found in the lower basin of the river Kapuas.

East Borneo.

In E. Borneo the Miocene coal appears, according to the latest investigations, to be widely distributed, especially in the state of Kutei, and in the northern states. The coal that was formerly held to be Eocene, is now considered to be of later age.

Pulu-Laut.

A few thin seams of coal are found on the south-western coast of Pulu-Laut.[1]

Brown coal is known to occur in the following places in the southern states:—Near Tandjong Batu in the Laut Straits (examined in 1353 by Rant)—two seams of brown coal containing much resin. The upper seam, 2·3 to 3·0 metres thick, underlies a loose sandstone, and overlies a ferruginous quartz-conglomerate, under which lies the second seam.

The strike is south-west and north-east; dip towards the north-west, 7° to 8°.

These seams could be traced for a distance of 100 metres[2]

In Kusan seams of brown coal occur in the rivers, not far from the sea-coast. Thus two narrow seams of about

---

[1] C. de Groot S. 23 p. 61 [2] Ib. p. 59.

0·50 metres thickness, occur in the river Saronga, about two hours' journey up-stream.[1]

"Plant-coal" also occurs in Tanah-Bumbu not far from the coast. It is associated with recent sandstones, and contains nodules of ironstone.[2]

Brown-coal was found by Hooze in the rivers that flow into the bay of Adang. The thickest seam (1·05 metres) has a dip of 10° to 30°.

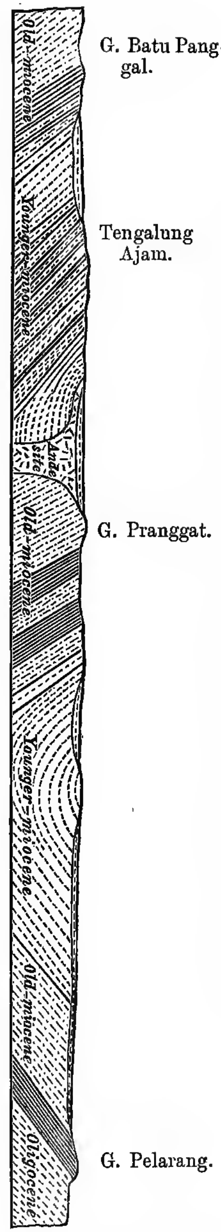
Unimportant coal-seams occur near Passir; also in the bay of Balik-Papan, but only thin beds of brown-coal with a north-east dip occur here.[3]

State of Kutei.

Up to the present only the coal beds near Samarinda, on the river Mahakkam, have been carefully examined.[4]

Characteristic for the district is the occurrence of a series of parallel hill-chains of an average height of fifty metres (ninety metres is the highest peak), the base of which is surrounded by marsh lands.

This Tertiary hill-land is exceedingly rich in coal. The mining-engineer, Hooze, distinguishes four coal districts.



SECTION OF THE COAL-FIELD NEAR SAMARINDA IN KUTEI.—E. BORNEO. (HOOZE.)

---

[1] Javaverslag v/h M. 1885, III. IV. I. cur.

[2] Schwaner E. 5.

[3] Javaverslag 1886, I.

[4] Hooze 14. It was prospected by Hooze, under Nagel's superintendence, from April untill November 1883.

1. The coal district of Batu Panggal, with ten coal seams, of which seven are workable, with a total thickness of eight metres.

2. The coal district of Tengalung, with eighteen seams, of which fifteen are workable, with a total thickness of twenty-one metres of workable coal. Also that of Gunong Lerong (the continuation on the left bank), with eighteen seams, of which fourteen are workable, with a total thickness of nineteen metres of workable coal.

3. The coal district of Gunong Damar and G. Salili; also that of G. Prangat (the continuation on the left bank), each with fifteen seams, of which eight are workable, with nine metres of coal.

4. The coal district of Pelarang, with ten coal seams, of which eight are workable, having a thickness of ten metres.

According to Hooze's calculations the following quantities could be raised by level-workings:—

		Tons.
In coal district	Batu Panggal,	200,000
„	Tengalong Ajam,	1,700,000
„	Lalok Lerong,	700,000
„	G. Dammar and G. Salili,	200,000
„	G. Prangat, -	200,000
„	Pelarang, - -	400,000
	Total,	3,400,000

By sinking a shaft in Pelarang, 1,500,000 tons of coal could be raised.

Up to the present the coal district of Pelarang has been held to be Eocene. Hooze considers it early Miocene, or Oligocene, while he considers the coal of Tengalong Ajam to be late-Miocene.

Brown coal occurs in the river Dondang, a tributary of the river Mahakkam, not far from the sea.

Coal Seams in the River Kutei (near Samarinda).

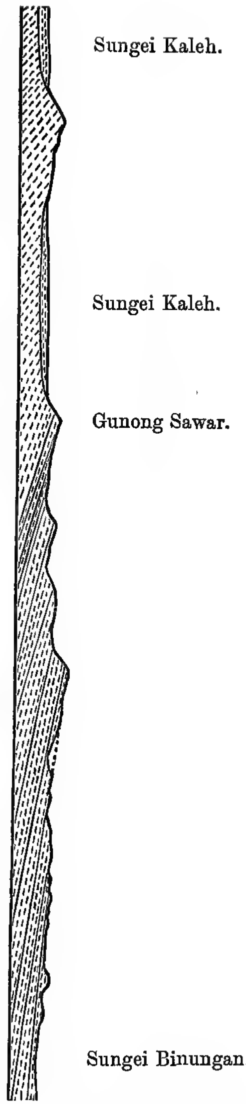
Locality.	No. of coal seams.	No. of workable beds.	Total thickness of coal.	Thickness of workable coal.	Average distance in Meters between the beds.	Length in metres of the cross section of the workable beds.	Amount of coal obtainable by level working.	Strike and dip of the coal seam.
Batu Panggal, ..	10	7	9·20	8·00 4·00 betw. No. 1 & 4.	600 100	6,000	200,000	60°–100° 45° 115°
Tenggalung Ajam,	18	15	23·08	21·00	1,000	5,000	1,700,000	40°–115° 30°–115°
Talok Lerong, ..	18	14	id.	19·00	1,000	2,000	700,000	30°–110°
Gunong Dammar and G. Salili,	15	8	12·61	9·00	320	1,000 4,000	100,000	60°–105°
Gunong Prangat,	15	8	id.	id.	id.	2,000	200,000	65°–125°
Pelarang, ..	10	8	?	10·00	285	800 1,000	400,000	25°–25° 30°–290°
						Total,	3,400,000	

Coal in State of Berau.

Coal is of widespread occurrence in this state,[1] and has been much sought for, especially near Gunong Sawar, and Gunong Ridjang.

[1] The prospecting was done from January, 1882, to April, 1883, by the mining-engineers Menten and Hooze, the surveyor Stremayer, and by the mining-captain, Nazel. (Jb. 1886, II. p. 1.)

1. The Gunong Sawar hill-chain lies on the right bank of the river Kaleh (a tributary on the right bank of the river Beran), ten kilometres south-west of Sambiliung, and about sixty-five kilometres from the coast (the Pantei mouth). The river is navigable here for vessels having a draught of ten to twelve feet, and there is only one difficult place—a sharp bend. On an average the hill-chain is sixty metres high, and the highest point reaches to ninety metres.



Section of the Coal Fields near Gunong-Sawar (Sambaliung, E. Borneo). (Hooze.)

Hard sandstones alternate here with shales; they contain eleven coal seams, which are separable into an upper and lower group.

The lower group is the thicker; it consists of five coal-seams, which, with a dip of 10° to 20° towards the sea, strike north and south, with a slight curve towards the interior, and probably, sweep round to the west, near Sungei Rottan.

The upper group consists of five coal-seams, and is separated from the lower group by seventy-five metres of sandstone (the horizonal separation = 300 metres). The strike of the seams is very irregular, and, consequently, their division into six seams is only a general interpretation of their relations by Hooze. The general strike is north and east the dip, 8° to 15° to the sea.

According to Hooze's calculations 2,180,000 tons of coal can be raised by level workings from the lower seams. This is distributed thus:—

Seam 1,	...	...	195,000 tons.
„ 2,	...	...	360,000 „
„ 3,	...	...	450,000 „
„ 4,	...	...	500,000 „
„ 5,	...	...	675,000 „
			2,180,000 tons.

And 1,250,000 tons from the upper group:—

Seam 6,	...	475,000 tons.
„ 7,	...	270,000 „
„ 8,	...	—
„ 9,	...	140,000 „
„ 10,	...	365,000 „
„ 11,	...	—
		1,250,000 tons.
	Total,	3,430,000 tons.

This less ten per cent. loss on working, and twenty per cent. for smalls, gives:—

1,500,000 tons for seams 1 to 5
and 875,000 „ „ 6 to 11

2,375,000 tons round coal.

By working with shafts (namely in stages of fifty metres depth above the adit or bottom level), 3,000,000 tons of coal could be raised for every 1,000 metres of length, and by spreading the shafts and levels over the whole of the district, a coal supply sufficient for many centuries could be obtained.

THICKNESS OF COAL SEAM IN GUNONG SAWAR (EAST BORNEO).

Seam.	Thickness of seam.	Quantity of coal.	Workable coal.	Strike and dip.	Horizontal distance from next seam.	Quality of coal.
				Degrees.	Metres.	
I.[1]	2·25	2·00	2·00	10 ,, 100	55	
II.[2]	2·38	2·35	2·35	12 ,, 100	25·0	Compact, black.
III.[3]	6·12	4·55	4·37	15 ,, 100 18 ,, 110 20 ,, 120	50—100	Do. with some Iron Pyrites.
IV.[4]	6·77	4·75	3·30	14 ,, 100 10 ,, 120	100	—
V.[5]	3·28	2·86	2·16	15 ,, 80 10 ,, 105 10 ,, 135	300	—
	20·28	16·51	14·18			
VI.	1·80	1·76	1·76	8–10 ,, 65 15 ,, 115	40	—
VII.	2·30	1·57	1·00	6–12 ,, 20 15 ,, 80	75	—
VIII.	1·16	0·71	0	12 ,, 25	150	—
IX.	0·68	0·68	?	10 ,, 25	80	—
X.	1·35	1·35	1·35	8 ,, 25 10 ,, 360	150	—
XI.	0·60	0·60	0	8 ,, 10 10 ,, 45	—	—
	7·89	6·67	4·11			

2. The coal opposite Pulu-Sepinang.—In the Ri-sid-jang hill-chain (striking south-east, with an average height of forty metres, the highest peak, G. Ridjang, being sixty-two metres), there are also thick beds of coal. These are on the right bank of the river Berau, opposite the island of Sepinang, forty-five kilometres from the coast (about twenty kilometres nearer than Gunong Sawar).

Here also two groups are to be distinguished.

The coal-seams of the lower or Ridjang group, four in number, are only of secondary importance in comparison with the upper group. The strike of the seams is curved; near G. Ridjang it is east and west, with a dip of 10° to the south; further south-west it is north-east and south-west, with a dip of 25° to the south-east, and near G. Kramat

[1] Average 0·25. [2] Average 0·03. [3] Varies.
[4] Five seams: 0·90, 0·25, 0·70, 0·30, 0·20. [5] Varies.

(to the west), it is north and south, with a dip of 35° to 40° to the west. The bedding is thrown into sharp folds.

The upper or Kaman group contains seventeen coal-seams, the outcrops of which are characterized by great regularity in bedding and composition. The strike is east and west; the dip, 25° to 30° to the south. The underlying and overlying beds are, almost without exception, shales.

A fine section of these seams is visible in the S. Kaman-kiri, above the confluence of that river with the S. Duri, where in a horizontal distance of 950 metres, all these seventeen coal-seams are exposed.

By level-workings alone three and a-half million tons of coal could be raised.

Coal seams in the River Segah above Gunong-Tabar.[1]

This coal district has only been superficially examined, and nothing more than the mere presence of coal-seams has been ascertained.

[1] Hooze, E. 13.

Section of the Coal Field opposite Pulu-Sepinang, on the river Berau (Sambaliung, E. Borneo). (Hooze.)

In the S. Biran, a tributary on the right bank, two seams occur in a hilly district (thirty metres' high). The one has

COAL SEAMS IN THE GUNONG RIDJANG (EAST BORNEO), OPPOSITE PULU-SEPINANG.

Group	No. of seams.	Thickness of seams.	Thickness of coal	Workable coal.	Horizontal distance between the seams.	Strike and dip.
						Degrees.
Ridjang = Lr. gr.	I.[1]	0·85	0·85	0	580 = 115 M.[4]	12-165
	II.[2]	1·36	1·36 average	1·36	25 = 5 M.[5]	15-195 10-180 15-93
	III.[3]	1·55	1·55 average	1·50	180 = 32 M.[6]	15-195 15-115
	IV.	1·00	1·00 M.	1·00	1,000 M.	15—20-150
		4·76	4·76	3·86		
Kaman = Upper group.	I.	1·00	1·00	1·00	45	25-190 23—25-185
	II.	2·25	2·25	2·25	50	idem
	III.	3·54	3·51	3·51	105	25—28-190
	IV.	2·20	2·20	2·20	55	idem
	V.	2·53	2·53	2.53	13	22-200 25-190 21-185
	VI.	0·50	0·50	—	32	25-190
	VII.	1·62	1·62	1·62	100	30-180 to 185
	VIII.	2·40	2·40	2·40	125	31-200
	IX.	1·65	1·65	1·65	50	25-190
	X.	0·30	0·30	—	25	30-190
	XI.	1·40	1·40	1 40	12	idem
	XII.	0·20	0·20	—	18	30-190
	XIII.	3·90	3·90	3·20	55	25-190
	XIV.	2 60	2·60	2·60	110	28-190
	XV.	2·30	2·30	2·30	125	31-180
	XVI.	0·75	3·70	—	30	idem
	XVII.	0·25	0·25	—	—	35-180
		29·39	29·36	27.36	950	

[1] Only one out-crop known. Coal very impure, probably would not repay working.

[2] Six out-crops known with coal thickness of 1·00 to 1·65 metres.

[3] Several out-crops known.

[4] Thickness of the rock.

[5] Only three seams are workable, together 3·86 metres thick.

[6] Of the seventeen coal seams, twelve are workable, having a total thickness of 27 metres coal, and a horizontal extent of 956 metres. Between the two groups there are three other coal-seams of 0·30 and 1·50 metres thickness, separated by 10 metres of sandstone, and as forerunner of the Kaman coal, a seam of 0·20 metres thick. The distance from the two first seams to seam IV. (Ridjang), is 575 metres, and to seam I. (Kaman), 500 metres.

a dip of 3° to south; the second, farther up-stream, dip, 37° to 45° to the west, and strikes south-south-east and north-north-west.

Several coal-seams occur in a range of hills, about fifty metres high (striking west and south) in the neighbourhood of the S. Samarattan, a tributary on the right bank (twelve kilometres above Gunong-Tabor).

In the G. Belauung there is a seam 2·20 metres thick, with a dip of 50° to the west. In the G. Anas, a seam of 1·50 metres, dip 50° to the west. In the G. Dewata, five seams of 2·00, 5·00 (?), 2·00, 2·10, and 0·75 metres thickness (dip 54° east by south, 60° west by south).

These beds are probably the highly-inclined limb of the G. Sawar coal. The coal is chiefly associated with clay-slates.

North Borneo.

Nothing known up to the present.

COAL IN DILUVIUM.

Only known in a few places up to the present.

South Borneo.

Three coal-seams occur in the Bukit Ulin,[1] which constitutes part of a hill-chain (fifteen to twenty metres high) in the middle of the Diluvium. The first two have a thickness of 0·15 and 0·3 metres respectively, the third is thicker; probably two and a-half to three metres. They alternate with beds of clay-ironstone conglomerate, and the dip is at a very low angle.[2]

The coal shows woody structure, is of a dull brown colour,

---

[1] Verbeek S. 41, p. 100.

[2] I am not satisfied as to the Diluvial age, as no stratigraphical details are given. I am more inclined to regard it as Miocene.

gives a dull brown powder, and contains a yellow resin. The composition is:—

H_2O,	...	...	43·82
Ash,	...	...	1·75
Coke,	...	...	43·02
Other,	...	...	11·41
			100·00

West Borneo.

Chinese Districts.

In the upper basin of the river Merau there occurs a horizontal bed of leafy coal 1·6 metres thick, overlying the Diluvial pebble bed. The coal is of a brownish-black colour; some parts are black and shiny, and contain much alumina. It underlies clay and humus.[1]

COAL IN ALLUVIUM.

South Borneo.

Peat-mosses.

An extensive peat-moss occurs between the rivers Kalamanan and Tjampaka, tributaries of the rivers Katingan and Sampit. It was crossed by Michielsen.[2]

Peat-mosses are also found in the district Dusson Timor.

Above the confluence of the S. Siong with the river Pattai, a broken land begins. The ground is covered with trunks of trees: heaped up one upon the other, are the remains of ancient forests. In the neighbourhood of the S. Hawayang this peat floor is covered with a splendid growth of vegetation. Broken land also occurs in S. Siong.[3]

[1] Van Schelle Jb. v/h M. 1884, I. p. 143. [2] Michielsen S. 46.
[3] Schwaner S 16, I. 91, 93.

Technical Value of the Black Coal.

Practical Tests.

As soon as coal-seams were discovered in the different districts, the coal was submitted to practical tests on the steamers, in order to determine its technical value.

Thus as early as 1847, Kutei coal was used on board H.M. ship "Etna." The report was favorable, although it burnt rather more rapidly than English coal.[1] In 1850, coal from W. Borneo (Bunut), was tested on the "Etna" and the "Tjipannas," and also found good.[2]

The same was the case with the Pengaron coal.[3] The tests carried out on the latter at different times, and on different steamers, gave very variable results, probably because the coal was derived from different seams.

For this reason further experiments were carried out in 1852 on the steamer "Vesuvius," the coal from the different seams being kept separate, and compared with English coal (from Aberdare in South Wales).

It was thus proved that the different seams do not yield the same coal. That obtained from the seams *a*, *c*, and *d*, gave the same result as English coal, as may be seen from the following table:—

		English Coal.	Pengaron Coal.
Evaporative power,	...	100·00	101·66
Ash, ...	...	10·40%	9·60%
Stones (Bats),	...	0·50%	0·46%

Coal from seams *e* and *f* was not suitable for use on steamers. That from seam *f* proved, however, a good smithy coal.

---

1 De Groot S. 23. p. 79.

2 B 5, B 6.

3 Jb. 1878, 153-213, the same in n.T. v. N. J. XXX.

It was further shown that the Borneo coal gave less small coal than the English, that it contained 8 per cent. less ash, and 8 per cent. less bats, and that 1h. 39m. was necessary for the production of steam against 1h. 30m. of the English coal. It was proved by chemical analysis that on complete combustion the best English coal gave 20 per cent. more, and the inferior 8 per cent. less heat than Borneo coal.

Up to 1859 no complaints were uttered with regard to Borneo coal; it was used by the navy in the whole of the Indian Archipelago, and also by private steamers.

Complaints began later, when the supply from Pengaron was stopped by the insurrection in S. Borneo, and its place taken by private supply from different places on the east coast, where the coal was not properly freed from impurity. This coal was of 20 per cent. less value than English coal.

When the Pengaron mine was in full work again, however, the complaints about Pengaron coal remained. The Civil Marine Service complained of its rapid and incomplete combustion, of its flaming, and of the high temperature produced by the combustion of the gases, which was said to be injurious to the boilers.

The Navy, after a series of trials, gave an adverse judgment, its effective value being estimated to be 27·8 per cent. less than that of English coal.

Experiments, such as were carried out between the years 1880–1890 on the steamers, especially on H. M. ship "Swallow," with Pengaron, Kutei, and Sambiliung coal, showed that Pengaron coal was of bad quality, giving 33 per cent. ash, and 9 per cent. soot. Kutei coal gave 15 per cent. ash, and 5 per cent. soot (good); Sambiliung coal, 7 per cent. ash, and 2 per cent. soot (very good). The great amount of ash given by the Pengaron coal was an especial subject of complaint, and a comparison of the later with the earlier analyses certainly shows that it has increased with the depth of the mine. This will, perhaps, also be the case with the lower beds of the Sambiliung coal. It should be remembered that Pengaron coal was much praised in the earlier years, just as the Sambiliung coal is now.

The result of the tests made on the coal of Tengalung Ajam (Kutei), show that it is not suitable for use on naval ships, on account of the greater consumption, amounting to 50 or 60 per cent., the difficulty of obtaining steam at full pressure, and the risk of fire, due to the volume of flame produced during its combustion. Its value is also small for industrial purposes.

Complaints are also made respecting Bunut[1] coal in W. Borneo.[2]

Technical Value of Kutei Coal.[3]

The coals of Batu-Panggal, G. Dammar, G. Salili, and G. Prangat, are of about the same quality.

They contain 10 to 13 per cent. water, 9 per cent. ash, and 1·70 to 2·95 per cent. sulphur. Tested practically they were found good as boiler fuel, but they must be considered injurious for the boilers on account of their high percentage of sulphur.

Pelarang coal is of the same character. It contains 14 per cent. water, 10 per cent. ash, and only 0·4 to 0·7 per cent. sulphur. As boiler fuel it is of 20 per cent. less value than English coal.

The coals of Tengalung-ajam and Gunong Lerong, are of inferior quality, since they contain 18 to 22 per cent. water, and 17 per cent. ash. According to experiments made on them, they are not suitable for use in the navy.

---

[1] Jb. v/h M. 1883, II, 93.

[2] The bad quality is partly to be ascribed to its treatment. The coal often remains exposed to air for months, and gets covered with mud. Further the coal is not properly screened, and is often supplied in an impure condition.

[3] Hooze E. 14 p. 90-93.

Technical Value of Berau Coal.[1]

The Ridjang-Kaman coal is of much poorer quality than that of Gunong Sawar. On account of its high percentage of water (30 per cent.) it is of little use for the production of steam. The consumption is 50 per cent. greater than in Gunong Sawar coal; and it crumbles on drying Externally the coal is black and lustrous, but somewhat duller than Gunong Sawar coal. Besides 30 per cent. of hygroscopic water, there is also 1·58 per cent. of chemically-combined water: the percentage of ash in the anhydrous coal is 5·64 per cent.

The Ridjang-Kaman coal is a brown coal.

The Gunong Sawar coal has also a high percentage (about 12·40 per cent. of water), and on this account it crumbles easily.

On account of the high percentage of water, Hooze refers this coal to a younger formation than the Eocene. It is of 20 per cent. less value than English coal.

The Gunong Sawar coal is worth working.

Price of the Coal.

The price of Pengaron coal was estimated, about the year 1880, to average 14·50 florins[2] at Banjermassin, or 9·50 florins at Pengaron, with an additional 5 florins for transport.[3]

In 1882, the price per ton was estimated at 5 florins for a yield of 24,000, and at 7 florins for a yield of 12,000 tons. The transport was placed between 3·50 and 3·60 florins. The Banjermassin price was 10·50 to 10·60 florins, while the

[1] Hooze, E. 13.

[2] On an average, between 1848 and 1859, 10·50 florins. Jb. v/h M. 1878, II. 154 according to De Groot. The Dutch florin is worth 1s. 8d. of our money.

[3] Jb. M. 1874, II. 31.

Java price was as much as 17 to 17·25 florins, the best English coal only costing from 19 florins to 22 florins at the same place.

Pelarang coal (Kutei), costs the government 8 florins per ton on the river Mahakkam. The Sultan of Sambiliung supplied coal at 14·50 florins per ton.[1]

According to Hooze's estimate,[2] Pelarang coal could, with a large production, be sold in Java at 12·50 florins per ton.

---

[1] Jb. v/h M. 1885, II. 251. [2] Hooze E. 14, p. 94.

Chemical Analyses.[1]

Coal from		C p. cent.	H p. cent.	O p. cent.	N p. cent.	H_2O p. cent.	Hygroscopic water, p. cent.	S p. cent.	Coke, p. cent.	Ashes, p. cent.	Volatile constituents. p. cent.	Calorific value.	Thickness of seam, metres.
I.—Eocene.													
1. *South Borneo.*—Tanah-Laut.													
Pengaron.	Seam *a*	71·70	5·48	13·00	1·50	4·90	—	0·32	59·90	3·10	—	6,079	—
	,, *c*	71·20	5·60	14·45	1·50	3·65	—	0·30	60·90	3·30	—	5,905	—
	,, *d*	71·00	5·00	11·37	1·50	6·17	—	0·26	60·70	4·70	—	6,102	—
	Average,	71·30	5·36	12·94	1·50	4·91	—	0·29	60·20	3·70	—	—	—
	,, *c*	69·50	5·25	13·43		—	—	0·04	52·40	6·50	—	—	—
	,, *d*	67·50	5·06	16·74		—	—	1·74	51·40	5·60	—	—	—
	,, *e*	67·70	6·21	16·64		—	—	1·50	52·40	4·20	—	—	—
Gunong Djabok,	,, *a* Sungei Liang, ..	50·59	5·04	—	—	3·88	—	0·50	66·66	27·69	—	—	1·20
	,, *b* S. Labak-Bassung, ..	63·63	6·21	—	—	5·24	—	0·60	60·62	11·16	—	—	1·18
	,, *c* Idem, ..	71·38	6·71	—	—	5·71	—	0·27	55·83	1·68	—	—	0·76
	,, *i* Sungei Tembata, ..	58·60	5·52	—	—	4·04	—	0·60	61·04	18·53	—	—	1.45
Djala-madi,	,, *h* ,, Tala-Duwa, ..	71·89	6·54	—	—	5·62	—	0·40	60·30	1·59	—	—	1·10
	,, *l* ,, Durian ..	67·29	6·26	—	—	4·79	—	0·60	59·26	7·63	—	—	0·88
G. Bla-gador,	,, *m* ,, Kalangkala, ..	66·00	5·70	—	—	3·08	—	0·10	57·29	8·73	—	—	1·10
	,, *p* ,, Bihi, ..	59·01	5·81	—	—	3·31	—	0·50	61·90	17·72	—	—	0·75
	,, *r* ,, Pantjur,	65·04	5·56	—	—	5·01	—	0·59	61·90	9·25	—	—	1·20
2. *East Borneo.*													
Pulu-Laut.	Tandjong Pamantjingan, ..	52·93	4·99	—	—	4·73	—	1·32	68·10	23·80	—	—	—
	,, Kamuning, ..	63·47	5·80	—	—	7·75	—	0·68	67·80	9·63	—	—	—
	Kotta-Baru, ...	59·36	5·70	—	—	5·79	—	0·61	66·06	16·70	—	—	—
	Sungei Pramuan, ...	57·00	5·06	—	—	6·24	—	0·62	70·30	21·70	—	—	—
	,, Djilapat, ...	65·03	5·73	—	—	6·07	—	0·61	63·40	10·53	—	—	—
	,, Damar-maas-besaar, ..	62·10	5·57	—	—	6·67	—	0·74	66·66	9·37	—	—	—
Island of Nangka opposite Pulu-Laut, ..		—	—	—	—	2·10	—	1·53	55·35	12·50	—	—	—

[1] See Analyses in Jb. v/h. M. 1875 I p. 54, 101, 106; 1878 II p. 202–206; 1884 II p. 316, 320; 1885 II p. 123, 125, 139 n. T. v. N. J. XXX; 1881

CHEMICAL ANALYSES—*continued.*

COAL FROM	C p. cent.	H p. cent.	O p. cent.	N p. cent.	H_2O p. cent.	Hygroscopic water, p. cent.	S p. cent.	Coke, p. cent.	Ashes, p. cent.	Volatile constituents. p. cent.	Calorific value.	Thickness of seam, metres.
3. *North Borneo.*												
ISLAND OF LABUAN,	72·27	5·20	14·28		6·10	—	0·30	—	1·85	—	—	—
II.—MIOCENE.												
1. *East Borneo.*												
a Oligocene (after Hooze).												
KUTEI. Batu-Pangkal, seam $1,_5$ break,	58·30	4·42	17·80	0·34	9·90	—	2·95	—	6·97	—	—	—
,, ,, ,, $2,_0$,,	60·01	4·40	17·19	1·73	13·30	—	1·91	—	1·46	—	—	—
River Sanga-Sanga,	—	—	—	—	14·90	—	0·90	53·90	1·24	—	—	1·42
Idem.	—	—	—	—	14·90	—	0·77	53·70	1·80	—	—	1·16
Idem.	—	—	—	—	14·20	—	0·50	56·20	0·62	—	—	4·30
Pelarang (seam No. 2),	—	—	—	—	14·40	—	0·50	55·40	1·60	—	—	1·40
Gunong Prangat,	—	—	—	—	10·90	—	2·56	53·20	2·25	—	—	0·17
Idem.	—	—	—	—	10·90	—	4·25	61·40	14·00	—	—	0·13
Idem.	—	—	—	—	9·20	—	2·23	54·90	1·99	—	—	0·35
Gunong Damar,	—	—	—	—	14·20	—	1·67	53·10	1·30	—	—	2·10
Idem.	—	—	—	—	13·15	—	2·07	56·60	6·30	—	—	1·20
Idem.	—	—	—	—	12·80	—	2·71	55·10	1·25	—	—	0·75
Idem.	—	—	—	—	13·50	—	1·13	61·00	2·26	—	—	0·70
Idem.	—	—	—	—	12·20	—	2·24	55·30	1·02	—	—	1·00
SAMBILIUNG. (Gunong Sawar),	56·54	3·76	18·05	2 07	17·76	—	0·32	—	1·51	—	—	—
b Late Miocene (after Hooze).												
BERAU. Gunong Lerong,	—	—	—	—	19·20	—	0·07	46·50	4·04	—	—	2·25
Idem.	—	—	—	—	21·40	—	0·43	54·30	3·75	—	—	0·95
Idem.	—	—	—	—	21·80	—	0·48	52·50	4·30	—	—	0·90
Idem.	—	—	—	—	19·80	—	0·36	51·80	2·50	—	—	1·10

CHEMICAL ANALYSES—*continued.*

COAL FROM	C p. cent.	H p. cent.	O p. cent.	N p. cent.	H_2O p. cent.	Hygroscopic water, p. cent.	S p. cent.	Coke, p. cent.	Ashes, p. cent.	Volatile constituents. p. cent.	Calorific value.	Thickness of seam, metres.
Tengalung-Ajam (Kutei), Seam No. 1,	—	—	—	—	18·30	7·20	0·80	53·27	3·00	—	—	1·15
,, ,, 2,	—	—	—	—	21·10	11·10	Averages 0.41.	52·87	3·10	—	—	1·00
,, ,, 3,	—	—	—	—	17·70	8·70		51·95	2·50	—	—	1·35
,, ,, 4,	—	—	—	—	20·40	9·00		53·42	2·27	—	—	1·80
,, ,, 5,	—	—	—	—	20·10	8·80		51·25	5·05	—	—	1·40
,, ,, 6,	—	—	—	—	20·10	9·80		46·62	3·22	—	—	0·80
,, ,, 7,	—	—	—	—	14·20	6·00		42·22	3·00	—	—	0·30
,, ,, 8,	—	—	—	—	18·80	7·80		45·67	2·57	—	—	1·80
,, ,, 9,	—	—	—	—	17·20	6·40		47·50	4·82	—	—	0·45
,, ,, 10,	—	—	—	—	17·70	7·60		51·27	3·00	—	—	0·65
,, ,, 11,	—	—	—	—	14·90	6·20		47·27	1·92	—	—	2·00
,, ,, 12,	—	—	—	—	17·80	6·60		45·32	2·37	—	—	0·80
,, ,, 13,	—	—	—	—	14·80	6·20		47·35	4·70	—	—	1·75
,, ,, 14,	—	—	—	—	17·40	9·80		45·82	2·77	—	—	1·90
,, ,, 15,	—	—	—	—	18·70	8·30		47·72	3·15	—	—	1·71
2. *South Borneo.*—Tanah-Laut.												
River Assam-Assam. Sungei Rakin, No. 1,	—	—	—	—	24·80	—	0·27	47·00	1·69	—	—	2·00
,, ,, ,, 2,	—	—	—	—	24·90	—	0·26	46·00	1·50	—	—	2·50
,, ,, ,, 3,	—	—	—	—	23·70	—	0·34	46·60	1·60	—	—	8·00
,, Kudung ,, 4,	—	—	—	—	22·70	—	—	43·00	2·38	—	—	0·90
,, ,, ,, 5,	—	—	—	—	20·70	—	0·34	40·00	1·11	—	—	2·00
,, ,, ,, 6,	—	—	—	—	22·10	2·93	2·48	48·28	1·12	—	—	6·50
Naya Ilir, ,, 7,	—	—	—	—	23·70	1·15	1·36	46·50	2·00	—	—	1·20
,, ,, 8,	—	—	—	—	23·80	—	—	40·10	2·37	—	—	0·80
,, ,, 9,	—	—	—	—	21·00	2·34	1·93	49·70	1·21	—	—	2·20
Naya Ulu, ,, 10,	—	—	—	—	23·90	—	0·22	45·40	0·80	—	—	6·40
Batu Belaman, ,, 11,	—	—	—	—	18·00	1·30	2·06	42·10	1·85	—	—	2·60
III.—DILUVIUM.												
Bukit Ulin (brown coal),	54·43		—	—	43·82	—	—	43·20	1·75	—	—	—

GOLD.

HISTORICAL.

The island of Borneo has long had the well-deserved reputation of being rich in gold. The occurrence of the noble metal was, probably, known to the earliest Hindoo population; and it is said to have been first found by the Dyaks, in the clayey floor of a cave, at the north-eastern foot of the Snaman mountains. (District Mandhor in W. Borneo.)[1]

When the first diggings were made, is not known; but it is certain that the noble metal has been worn by the natives since the earliest times. Its mode of occurrence, as alluvial or drift gold, made it easy to obtain; and its application for purposes of ornament and exchange, caused the natives to search for it.

We possess more exact information with regard to the gold obtained by the natives since the year 977, in which year the then native prince of the states between the rivers Sambas and Landak, in W. Borneo (now known under the name of the "Chinese Districts"), sent an embassy to the emperor of China. Chinese historians mention that, at this time, it was customary in Pu-ni (the name given by the Chinese to this state in W. Borneo), to make bridal gifts of gold when a marriage took place. Consequently, gold must have been mined at that time. Again, in 1406, an embassy from this state came to China, and it is recorded that the prince wore clothes woven of gold wire.[2]

But comparatively little gold was obtained by the natives, in consequence of their primitive methods. The people who most busied themselves with the production were, and are still, the Chinese. Attracted by the extent of the gold-fields, they settled down in the richest gold districts of W. Borneo, in the territory between the rivers Sambas and Landak, in

[1] Jb. v/h M. 1879, I., p. 9 and 50. [2] Ib. 1881, I. p. 265.

such numbers that these districts are now known as the "Chinese Districts." In the fifties the population of Chinese settlements in these parts amounted to 34,000; while in the whole of the western part of the island, there must be about 50,000.[1]

The greatest immigration took place after the arrival of the Dutch. Although a trading connection with them existed, even before the 13th century, still it can be safely assumed, that W. Borneo was not visited by the Chinese before the 13th century. In S. Borneo the Chinese seem to have immigrated at a much later period. Up to the third decade of this century, only a few Chinese were engaged in gold-washing, as the Sultan of Banjermassin was afraid to invite many settlers, for fear that he should afterwards be unable to control them.[2]

But the gold was not regularly worked by the Chinese till later. About the year 1760 the prince of Mampawa (W. Borneo) allowed his gold-fields to be worked by the Chinese; and soon after they obtained working rights in Sambas and Larah (Benkajang). The first of the larger settlements existed in Montrado and Larah, and the yearly rental paid to the Sultan of Sambas amounted to 500 thail (=27 kilogrammes) of gold dust. Between 1775 and 1780 the Chinese obtained a footing in the neighbourhood of Mandhor, and drove out the race then living there.[3]

While the natives mostly contented themselves with working the easily accessible alluvial gold, and seldom attacked the auriferous gravel (drift), or the out-crop of the dykes, the Chinese, on the other hand, introduced a systematized method of working, and while paying most attention to the detrital deposits, also worked the gold-bearing veins to a certain depth, in doing which they were not deterred from erecting large and expensive plant.

---

[1] Veth, Westerafdeling van Borneo, W. 17. [2] T v. N. J. 1838, I. p. 409.
[3] Jb. v/h M. 1881, I. p. 265.

They formed co-operative unions, or *Kongsies*, in which every member participated in the common profit. At first, these were only mining societies; but, as their power began to grow, they assumed a political colour, becoming, in fact, small federal republics. Their punishments were very severe. An ordinary theft was paid for with the loss of an ear; the robbery of gold-dust, with death, the cook being usually entrusted with the office of executioner.[1]

After much schism and re-union among the various societies, three powerful *Kongsies* were formed; namely, those of Lan-fong, Thai-Kong, and Sam-Thiau-ken.

By co-operating in this way, they had greater means at their disposal, and were enabled to erect better plant (water-channels and reservoirs), and to extend their labours over a larger area.

This was the most flourishing period of the Chinese miners. With increased power, the Chinese longed to make themselves independent of the native princes. After prolonged fighting they succeeded in this; and then in their turn they commenced to oppress and ill-treat the native population (Malays and Dyaks).

In the beginning of this century, when the colonies came under the direct rule of the Netherlands, quarrels broke out between the Indian government and the Chinese miners. As the government did not bring sufficient power into action, war was carried on for a long time, with varying fortune, without the Chinese being conquered. In 1850, the government determined to put an end to this unsatisfactory state of affairs, by sending a larger complement of troops. After four years of continual fighting the Chinese were completely subjugated, and their political combinations suppressed. They now came under direct European control, but retained their Chinese chiefs.

---

[1] Veth W. 17.

These long wars were the ruin of the once flourishing gold-mining industry. Thousands of industrious workers were killed or scattered; while fresh workers did not arrive to take their place. The sums of gold held in reserve had to be expended on the wars, and at the conclusion of peace, there remained neither money nor workers. In the course of years these conditions became slightly ameliorated, but the former height of prosperity has never since been reached.

The Dutch traders came to W. Borneo, first in 1608. They settled in the states Landak and Sukadana, and in 1778 these states were made over to the East-Indian Trading Company.[1]

In the early years gold was not mined by Europeans; and only since the eighties has a company been started in S. Borneo for the purpose of raising gold and diamonds.

In the year 1880, the French mining-engineer, Simonar, began to prospect in the neighbourhood of the Gunong Lawak, in Tanah Laut, a neighbourhood which had been completely dug over by the natives many years before. He obtained for this purpose a concession which permitted him to dig within a certain area, in the neighbourhood of Martapura, for diamonds, gold, platinum, and coal, for a period of seventy-five years. As royalty, he was to give six per cent. of the total gain.[2]

In 1882 the plant was erected, amongst which was a railroad of 0·4 metres guage.

In 1883 the concession passed into the hands of a "Borneo Mining Company," the transfer being confirmed by the Indian government.

OCCURRENCE.

Gold occurs in Borneo in three different ways: in the river-beds as alluvial gold, in the diluvial deposits as drift

[1] Radermacher B. I.

[2] Jb. v/h M. 1882, II. 137; 1883, II. 161; 1884, II. 372; 1885, II. 327; map of them, Ib. 1882, II.

gold (*Seifen*), and in the original place of deposition in the parent rock. The first two modes of occurrence are found in all parts, but the latter is, up to the present, best known in W. Borneo, according to the latest investigations, it is found in S. Borneo (Tanah-Laut) and in Sarawak.

Alluvial Gold.

If we are to give credence to the reports and statements of the natives, the greater number of the rivers of Borneo contain gold-sand in greater or less quantity. This has been confirmed, partly by mining investigations, partly by scientific travellers, as well as by the reports of European officials.

The gold-sand is of wide-spread occurrence in the rivers of S. Borneo, but in varying quantities.[1] In the river Barito it is found throughout the greater part of its course. Of its tributaries, those which take their source in the north, in the district Siang-murong, contain the most gold. On the other hand, those lying more to the south, the rivers Lahay, Teweh, Montallat, and Ajo, as well as the unimportant tributaries on the right bank, have no gold.[2] In the rivers Karrau and Pattai, of the district Dusson, gold occurs in workable quantity (at least, such was the case in former years). The richest are those rivers which, taking their source in Tanah-Laut, in the extreme south-east of the island, flow directly into the sea of Java.

The streams that lie more to the west of S. Borneo, also contain gold. Thus gold-sand occurs in the river Kapuas, and in its tributaries Kawattan, Pahokap, and Mowat. Similarly it is found in the river Kahajan, of which the upper course is renowned on account of its richness in gold, as well as in its larger tributary Rungan, and the smaller tributaries, Miri, Tiong, Hawaung. Gold also occurs in the river Katin-

---

[1] Schwaner, Borneo, S. 16; Von Gaffron S. 27.

[2] Gold has not been washed in these rivers; it does not follow, however, that there is none there.

gan, and in its tributaries Guno, Senamang, Ketjan, Dukei, and Pakso. The same is the case with the river Sampit, the rivers Mentaja, Kwajan, and the watercourses flowing from the Mentaweh mountains. Gold-sand is also found in the river Pembuang, and in the rivers Sanduh, Lamandung Koang, Ajung, etc., as well as in the river Kottaringin, and the tributary streams Kumei, Biru, Sambi, Arut, Lamandau, Tjinabawang, Delang, and Bulik.

But the quantity of gold-sand varies considerably in the different rivers. The richest are the rivers in Tanah-Laut, and in the district Siang-murong, as well as in the upper basins of the river Kahajan; on the other hand, the above-mentioned tributaries of the river Barito, do not contain gold in sufficient quantity to repay working. The causes of this will be discussed in treating of the diluvial deposits.

What has been said with regard to the rivers of S. Borneo, is also true of the western part of the island. Here it is the rivers Sambas and Landak, and the water-courses lying between them, that are especially rich in gold.

The rivers of the southern states Simpang, Sukadana, Matan, Kandawangan, also contain gold, but in much smaller proportions. The river Kapuas, and its tributaries Tajan, Meliau, Sanggau, Sikajam, Labojan, Bunut, Bojang, Djonkong, etc., are gold-bearing; so also is the mighty tributary Melawi, with its tributaries, the Serawai and the Tjerundung.

In E. Borneo, nearly all the rivers of the southern states, Kusan, Tanah-Bumbu, and Passir, are all said to be rich in gold. The rivers in the state Kutei, appear to contain little, and some of them none, while the upper course of the river Berau is said to contain gold-sand.

In N. Borneo, in the state Sarawak, only the western rivers contain gold. Up to the present no details are known with regard to Brunei. According to ancient reports, gold occurs in not inconsiderable quantities in the rivers Maluar, Belung, Tumegang, and Segamah; but the first proof of this was obtained in 1883, by Captain Beeston, in the river Segamah, and in the tributaries joining it in its middle course (especially Belung).

According to later reports, gold is also to be found in small quantities in the two rivers bearing the name Sapaguya, in the bay of Sandakan, and the bay of Darvel, in the river Kinabatangan, in the neighbourhood of the river Quarmote in the river Sugut and other rivers.

The gold-bearing rivers appear, accordingly, to have a fairly wide distribution on the east coast of Sabah.

Not only is the amount of gold[1] very variable, in the different rivers, but it also varies in the course of one and the same river. It is a remarkable fact, but easily explained, that the amount of gold in the river-sand is inconsiderable in the lower positions of its course, that it increases in the middle and upper course, and that the tributaries are the richest in gold. This is easily understood: for the river gold is principally derived from the alluvium surrounding the diluvial deposits, and the latter lie nearest to the upper river-courses. It is also explained by the fact that the gold, being the specifically heaviest of the fragments borne along, sinks most quickly to the bottom, and only the relatively lighter portions are swept on down-stream. That the amount of gold does decrease towards the mouth, can be seen by the returns of the gold washing, which diminish constantly as we descend the rivers.

The material obtained by washing is most frequently gold-dust, consisting of the smallest grains; but sometimes scales and larger grains occur. The largest piece found in Sarawak, came (according to St. John) from Krian, near Bau, and is said to have weighed seven ounces.

The gold-dust is always mixed with quartz-sand, sometimes with iron-sand (magnetite).

---

[1] Handbook of Sabah, N. 27.

The gold-dust is chiefly derived from the drift gravel beds, but also in part from original vein-deposits; after heavy rains, small quantities of gold collect in the water-courses, as at the foot of the gold-bearing slate-mountains between Snaman and Mandor (W. Borneo).[1]

Diluvial (Drift) Gold.

Distribution.

The gold in the diluvial deposits (drift), has a widespread occurrence in Borneo. The great extent of these deposits is also shown by the wide distribution of the gold-bearing river basins, which, for the most part, derive their gold from them. The amount of gold is, however, very variable, as will be shown in the sequel. While in some districts great masses of the noble metal occur, others have only small quantities of it; and in others again, the gold only occurs in traces, and the beds do not repay working.

In S. Borneo the richest and most widely distributed deposits are those in the Tanah-Laut mountains, the spurs of the mountain-chain in the south-east point of the island. It is especially the south-western part which is renowned for its gold-wealth.[2]

The zone containing the parts rich in gold begins not far from Tabanio on the coast, and extends in a south-west and north-east direction towards Martapura. It follows the foot of the mountains, and extends for more than five geographical miles. Within this zone there are, however, other districts which contain gold in considerable quantity, as, for instance, Pelei-hari, Pontein, Martapura, and Tjempaka. The districts richest in gold and platinum extend along the foot of the main mountains, which consist of serpentine and gabbro.[3]

---

[1] Jb. v/h M. 1879, I. 105. [2] Von Gaffron, S. 10.
[3] Javaverslag, 1883, IV.

Following the mountain-chain further towards the north, the gold-fields (belonging to the basin of the river Barito), become much poorer in comparison to those in the Tanah-Laut district. In the upper basins of the tributaries Pattai and Karrau (district Dusson Timor) gold mines are still to be found.[1] But further north, in the basins of the rivers Ajo, Montallat, Teweh, and Lahay, few or no auriferous deposits occur, at least not in payable quantity. In the district Siang-Murong, however, abundant gold of a very pure description is found.[2]

Gold-fields are also present in the western river basins. They are widespread in the upper basin of the river Kapuas but the quality of the gold is not always constant. Thus the gold found in the tributaries of the Kawattan, Pahokap, and Mawat, is of less carat than that of the Kapuas itself.[3]

The basin of the river Kahajan is well-known on account of its richness in gold, the upper course of the river, and its greatest tributary Rungan, as also the rivers Miri, Tion, and Hawaung, are especially celebrated.

In the basin of the river Katingan, the tributaries Gowo and Senamang, are renowned, pieces weighing 200 grams. having been found there; further, the rivers Ketjan and Dukei. The finest gold comes from the river Pako.[4] Schwaner's report shows how widespread the gold deposits are in these river basins. This traveller traversed the upper basins of the rivers Kapuas and Kahajan as far as the Katingan, for a distance of about eighteen geographical miles, and found everywhere both new and abandoned gold mines. In some cases the output was considerable, and constituted the chief pursuit of the native population. But gold is only washed in the neighbourhood of settlements; the remoter districts are avoided by the natives from fear of the savage races that frequent them.[5]

---

[1] Schwaner S. 16, Borneo I. p. 97.
[2] Ib. S. 16, I. 127.
[3] Ib. p. 155.
[4] Ib, II.
[5] Ib. Borneo II

In the basins of the R. Sampit gold deposits are known in the neighbourhood of the Mentaweh mountains, in the basins of the upper Mentaja and the Kwajan; also in the basins of the rivers Pembuang and Kottaringin, and the tributaries already mentioned.[1]

Turning our attention once more to the distribution of the auriferous drifts in S. Borneo, we see that it occurs at the foot of the whole of the south-western mountain-chain from the river Kottaringin to the Barito, in the district Siang-Murong. Along the north-eastern boundary of the mountains, however, it only occurs in the southern parts,—in Tanah-Laut, as far as the district Dusson Timor, with a decreasing amount of gold. Then the gold-fields cease, until the interior of the island is reached. The cause of this unequal distribution lies in the geological relations of the "mountain-land." As already mentioned the mountain-land is much developed in the south-east and centre of island in the north; and the same is the case with the gold-bearing rocks. But from 1° south latitude to 0° it is quite subordinate, thence the absence of gold.

In W. Borneo we have the same relations: the wide distribution of the auriferous gravels and the great variation in the amount. Gold is dug or washed in all the districts, except on the sea-coast, and in the districts Pontianak and Sungei Kakap, lying between the mouths of the river Kapuas.[2]

The richest gold districts are in the north-west, in the district between the rivers Sambas and Landak, the so-called "Chinese districts." Here drift gravels, which are more or less rich in gold, are found everywhere, and here also the greater number of the mines occur.

The amount of gold in the drift deposits is much less in the southern states Simpang, Sukadana, Matan, Kandawangan, although they have a geological structure similar to that of the first-mentioned districts. The number of the

[1] Von Gaffron S. 27. [2] Jb. v/h M. 1882, I. p. 45.

mines is very small here, and even in the beginning of the fifties there were scarcely any miners left.[1]

Auriferous drift is also widely distributed in the basin of the Kapuas. It is found in many places[2] along the river from Tajan to Salimbau; *e.g.*, below Tajan,[3] near Sintok and Sama rangkai, between Sanggau and Skadau (especially near Ingis), near the mouth of the river Aja[4] and Spauk, near Sintang, near Penei, and the mouth of the river Silat, near Salimbau. The upper basin is also rich in gold.

It is also found in the districts of the tributaries of the Kapuas; thus in the basins of the Tajan, Meliau, Sanggau; further in the basin of the river Sikajam, which is especially rich in gold in its upper basin, near the boundary with Sarawak, as is also the case with the upper course of the river Sabojan.[5] Also to be mentioned are the rivers Skadau, Spauk, Silat, Djonkong, and Bunut, with the tributaries Mentiba and Tebau.

Gold is also of widespread occurrence in the basin of the Melawi, the important tributary of the Kapuas, *e.g.*, near Blintjong, Pinoh, Gandis,[6] especially in the basins of the rivers Serawi and Tjerundung, where much gold of good quality occurs.[7] The same is the case in the upper basin of the Melawi.

From the above it will be seen how widespread is the auriferous drift of W. Borneo. The greatest amount of gold, however, is found in the "Chinese districts," the whole amount of the gold in the other districts is trifling compared to that found in these districts.[8]

---

[1] Jb. v/h M. 1879, I. p. 101.

[2] Its distribution can be well seen in Everwyn's Geological Map of W. Borneo, Jaarboek v/h Mynwezen 1879, I.

[3] Jb. v/h M. 1879, p. 12-44.

[4] Gerlach W. 45.

[5] Jb. 1880, II. p. 37.

[6] Schwaner S. 16, Borneo II. p. 178.

[7] Jb. 1882, I. p. 45.

[8] Gallois E. 9 and Weddik E. 3.

Although our information with regard to E. Borneo is rather deficient, the distribution of the gold districts can be made out.

The greatest amount of gold occurs in the southern states, Kusan, Tanah-Bumbu, and Passir.[1] In the first-named state the gold fields extend along the mountain border throughout the whole length of the land. In Tanah-Bumbu, the districts Sampanahan and Menungul,[2] are especially rich. In Passir the best district for gold is in the boundary mountains, near the Susubang mountains.[3]

Not much gold is known to occur in the state Kutei, although this state is known in the same proportion as the southern states. Gold-dust was shown to the traveller, Carl Bock,[4] on his journey towards the interior in 1880, but the natives would not inform him of the locality. With regard to the northern states our information is still exceedingly deficient.

In the state Berau,[5] gold is said to occur in the highlands. In the upper basins of the rivers Segah and Kelai (tributaries of the river Berau), the natives (Punans), are said to wash gold, and to bring it to the coast for sale. But no strangers are allowed to set foot in their land. So much gold is reported to occur in this country, that when a stick smeared with gum is pushed into the ground, it comes out covered with gold-dust.

In the state Bulongan,[6] lying more to the north, no gold is said to occur, and similarly we have no information with regard to its occurrence in the Tidung states.

In N. Borneo the best known gold districts are in Sarawak. They are situated over a great part of the country, but chiefly in Sarawak proper. Auriferous drift is worked at Bau, Paku, and Gumbang; in the Samarahan districts at

---

[1] Hageman E. 7.
[2] Bock S. 44.
[3] Hageman E. 7.
[4] Bock S. 44.
[5] Gallois E. 9 ; Weddik E. 3 ; Hageman E. 7.
[6] Gallois E. 9, and Weddik E. 3.

Sirin; and at Malikin[1] in the Sadong district. In the basin of the R. Batang Lupar, Marup is the best-known locality.[2] This place lies fifteen geographical miles from the coast, in a valley, several English miles wide, surrounded by picturesque mountains. The rich gold-field is worked by Chinese. Gold is occasionally found in the floor of some of the limestone caves, *e.g.*, Batu Kaladi. The earth filling the fissures and cracks of the limestone contains more gold than the country rock.[3]

Nothing is known of gold-fields in the state Brunei, and only a little is known of Sabah, in the north-west part of the island. In the latter state, gold-fields are said to exist on the peninsula Usang, that were worked by Chinese in the forties, who however soon abandoned the place on account of the hostility of the natives.[4]

According to latter information, gold occurs in the middle basin of the river Segamah.[5] The Diluvial deposits extend along the river for about 120 English miles, according to information supplied by Captain Beeston, from Duson village to the mouth of the river Belung, this being as far as he went.[6] This gold-field was worked by the Chinese.[7] According to information received by letter from Everett, however, the gold does not occur in payable quantity.

The distribution of the gold in Borneo is very irregular. If the island is divided into a south-westerly and a north-easterly half, the latter will be found to be very poor, the former rich in gold. It is true that more is known with regard to the south-western half than of the north-east. But this will not explain the great difference that exists.

In the south-western half there are again two districts which are especially rich, the remainder being comparatively

---

1 Everett N. 23, p. 16.
2 Crocker N. 34.
3 Low, N. 1.
4 T. v. N. J. 1849, I.
5 Fr. Hatton N. 48.
6 See his report, N. 49, p. 83.
7 *British N. Borneo Herald*, 1887, No. 7, p. 170.

poor. These two districts are the south-east point of the island (Tanah-Laut and Kusan); and the north-west (Sambas and W. Sarawak). The mountains here appear to be very rich in gold-bearing rocks, for rich auriferous drift extends along the declivities on both sides of the mountains, while the rivers, which take their source in them, all contain gold.

A third rich gold district appears to exist (according to Schwaner), in the upper basin of the Kahajan, but nothing is known of it, for excepting Schwaner, it has not been visited by Europeans.[1] This district lies between the two first-mentioned, all three lying in a straight line striking north-west and south-east, while to the south-west and north-east the gold-wealth rapidly decreases. The mountain-land in the interior of Brunei and Bulongan, and in the Tidung states must contain very little gold, since none is known to occur in these districts. These facts give an indication of the structure of the unknown interior, in the same way as the absence of auriferous drift in the boundary land between Kutei and S. Borneo, points to the limited occurrence there of mountain-land.

Sub-division of the Diluvial Deposits.

In the auriferous deposits of Diluvial origin, a distinction is made between hill-deposits and valley-deposits.[2] The first have been formed in place, the latter by floods.

The valley-deposits must again be divided into those formed in the interior, and those formed on the coast.

The Chinese miners adopt a different terminology for the

---

[1] In part also by Maks, S. 24.

[2] Already in the forties we hear of wet and dry diggings (mountain and valley-deposits, E. A. Francis, W. 3, p. 23). Our information with regard to the gold-drift in Borneo is much smaller than that relative to the tin-washings in Bangka, the cause being that it is only since the beginning of the eighties that especial mining investigations have been undertaken in Tanah-Laut, and in the Chinese Districts.

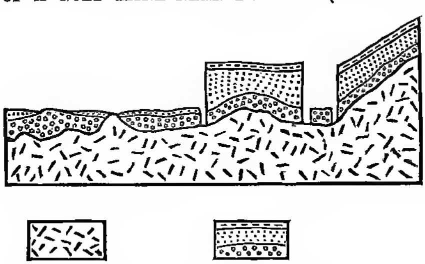
gold-deposits.[1] They distinguish between *Kulit, Kollong,* and *Kulit-Kollong* mines, according to the depth of the pay-bed, and the relative height of the water conduit. If the conduit is deeper than the pay-bed, they speak of a Kulit-mine (Kulit=surface or crust); in the reverse case, of a Kollong-mine (Kollong = deep.). On the other hand Kulit-Kolling is the name given to the mines which from the depth of the pay-bed would be counted as Kollong-mines, but from the mode of working adopted, as Kulit-mines. In general the Kulit-mines belong to the "mountain-deposits," the Kollong-mines to the valley-deposits and the Kulit-Kollong-mines to one or the other group.

Hill-deposits.

(" Berg-seifen "—Kulit-mines).

These deposits occur at the foot of the ore-bearing mountains,[2] and on the declivities of the mountains themselves, sometimes up to 500 feet![3] and also form a flat or undulating country. The ore is generally irregularly scattered

SECTION OF A GOLD MINE NEAR PONTAIN (AFTER SCHWANER).



through the whole thickness of the deposit, and mixed with humus, clay, and mountain-detritus. The thickness of the deposit varies from several decimetres; it is thickest between the hills, as it cannot there be so easily carried away.

[1] The auriferous deposits are called "Parit" by the Chinese.

[2] Its distribution in the granite-district is well-shown on Everwyn's map of W. Borneo, in the Jaarboek v/h M. in N. I. 1879, 7.

[3] S. Müller, S. 22.

The foot-wall (Chinese "Kong"), is always formed by weathered granite, diorite, serpentine,[1] etc., with an undulating surface, in the depressions of which there generally is abundant gold.

The mineral wealth varies considerably in the different districts, and even in one and the same district it is very variable.

With regard to the origin of the hill-deposits there is nothing new to add. The vein-quartz (more especially the quartz-crystals, where the gold chiefly lies), becomes mechanically fractured, and the gold is set free by decomposition of auriferous pyrites. The gold-bearing slates weather into clayey masses, and the felspathic eruptive rocks furnish kaolin and quartz. Quartz and clay are in part washed away, leaving the heavier gold to accumulate.

Valley-gold Deposits.

(" *Thal-seifen*"—*Kollong-mines*).

Very little is known with regard to these deposits, as they have not been much worked on account of the technical difficulties. It has already been stated that it is necessary to distinguish between the coast-formation and the deposits in old valleys.

The character of the beds is, on the whole, the same everywhere, but the thickness of the different beds varies considerably.

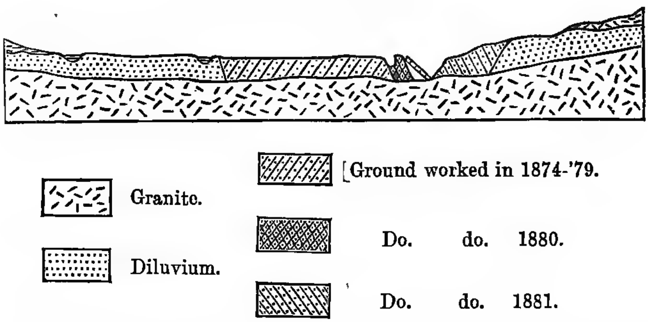
The hanging wall, which is always present, consists of sandy clay, in places coloured red by iron-oxide; it is sometimes conglomeratic, containing fragments of various rocks, *e.g.*, fragments of diorite in the mines at the foot of mount Sakumbang (Tanah-Laut). In the mines near Gunong-Lawak (Tanah-Laut), at a depth of two to three metres,

---

[1] Andesite (mine Penno in Tanah-Laut, Verslag in *Java Courant*, 1884, III.)

an iron anchor, and remains of houses, tree-stumps of oak, etc., were found.[1] The thickness of the hanging wall varies from one-half to three metres.

SECTION OF THE GOLD MINE SIM-PI-TU NEAR BENKAJANG (AFTER VAN SCHELLE).



The pay-bed consists chiefly of fine and coarse quartz-sand, through which the gold is disseminated. It contains, besides more or less abundant pebbles of different rocks, quartzite, siliceous schist, rock-crystal, serpentine, diorite, granite, etc.

Of practical importance for the gold-diggers, is the presence of bluish-grey rounded corundums (formerly mistaken for quartz), the presence of which is said to indicate the presence of abundant gold. Pebbles of tourmaline, boulders of coral-limestone, occur more rarely (R. Mentiba, tributary of the Bunut, W. Borneo);[2] and boulders of coal[3] (in the mines near Sintang, W. Borneo),[4] fossil sea-shells, such as Ostrea, Cardium, and Corals (Gunong Lawak, in Tanah-Laut), and fossil wood are also found.

Sometimes, however, scarcely any pebbles are found, as *e.g.*, in the mine Kajan (upper basin of the Sikajam in

---

[1] S. Müller S. 22.

[2] Everwyn W. 39, p. 21.

[3] Von Lynden W. 11.

[4] It is remarkable that the ash of the pyritous coal of Batu Belaman (Assem-Assem, Tanah-Laut), contains gold (Jb. v/h M. 1885, II. 114).

W. Borneo). Here only a little quartz-sand is obtained by washing, but much magnetite and mica.[1]

The gold-bearing stratum is sometimes knit together by a silicious cement into a compact mass like stone, which only can be broken by the use of a crowbar (Tanah-Laut, Skadau, etc.)

The thickness of the pay-bed varies from a few decimetres to a metre and over. Its depth reaches six metres, and even more, according to some experienced miners. The foot-wall (Kong), also called "dead earth" (*todte Erde*) consists, as in the case of the hill-deposits, of much-weathered rocks *in situ,—e.g.*, serpentine, diorite, granite, clay-slate. When the miner reaches this bed he ceases digging, as he knows by experience, that below it no more gold will be found.

The gold exists in the deeper pebbly layers, and varies in quantity. It is chiefly present in minute grains, but sometimes in coarser grains or scales. It is also attached to fragments of quartz, and in this way indicates its origin. Usually it is mixed with magnetite and chrome-iron ore, which gives the gold-dust a blackish colour—hence its name, "black sand," or "Puja."

The iron-sand is extremely fine, but it sometimes contains small crystals of magnetite[2] up to six millimetres in diameter, also botryoidal hæmatite of the same size and limonite Diamonds accompany the gold in the diluvial beds, *e.g.*, in several places in southern Kottaringin, and S. of Martapura,[3] in Tanah-Laut (S. Borneo); in Tanah-Bumbu and Kusan (Pagattan,[4] S. Borneo); in Landak, and in the upper basin of the R. Sikajam, in the mine Pelinjung[5] (W. Borneo).

Besides diamonds we have:—platinum—in Tanah-Laut and in the southern Kottaringin (?) (S. Borneo); quicksilver —in Tanah-Laut, in the mine Pleihari as amalgam, and,

---

[1] Jb. v/h M. 1884, I. 133.
[2] C. de Groot, S. 23, in Jb., p. 54.
[3] Müller, S. 22.
[4] Weddik E. 3.
[5] Van Schelle W. 62, p. 132.

according to Von Gaffron, in the southern Katingan and Kottaringin: further as Cinnabar in W. Borneo, in the rivers Bojang and Betung[1] (upper basin of the R. Kapuas), in the upper basin of the Sikajam,[2] and a few other places in the Chinese Districts;[3] and in Sarawak proper, in pebbles associated with laterite. Further, copper ore and antimonite.

With regard to the extent of the workable valley-deposits and the distribution of the ore, we have no information.

There is not much that is new to be said on the formation of the valley-deposits. The weathered portions of the gold-bearing rocks were swept away by water, the heavier gold settling to the bottom. The quantity of the gold is increased by additions from the sides of the valley, or from the hill-deposits in the neighbourhood. For this reason, the valley-deposits are, in general, richer than the hill-deposits. Later on the hanging wall (clay and sand) was deposited, and the former valley filled in with drift.

Age of the Diluvial Deposits.

We have no positive data with regard to the age of these deposits. They appear, however, to be of very recent age, as Horner indicated in the thirties.[4] In favour of this view is the discovery of fossil sea-shells—Ostrea and Cardium—in the gold stratum (Gunong Lawak): this also points to a littoral formation, as does also the discovery of the remains of houses and of an iron anchor in the hanging wall. Prof. Martin has proved the recent age of the tin deposits in Bangka and Billitin.[5] According to him they are in no case older than the Quaternary period, perhaps they are even of recent age. The same age may be assumed for the auriferous deposits in Borneo.

Whether older auriferous deposits also occur in Borneo,

---

[1] Van Schelle, W. 42, p. 15.
[2] Ib. W. 62, p. 123.
[3] Everett, N. 23.
[4] Müller, S. 22.
[5] Jb. v/h. M. 1884, I.

as in W. Sumatra, is not known. In the latter country the Eocene sandstone (stage γ) in the neighbourhood of Bukit Kandung and Pandjalangan, contain numerous gold-bearing quartz-pebbles, derived from the quartz-veins of the "old slates."[1]

Gold in its Original Place of Formation.

The earliest observers drew correct conclusions from the drift deposits, as to the occurrence of gold in the solid rock. Thus Horner,[2] in the thirties, mentions that many metalliferous veins and quartz-veins containing a little gold, occur in the syenite, gabbro, serpentine, and diorite of the Ratus mountains (S. Borneo). All these rocks contain much magnetic iron-ore, often present in great masses. Similar conditions were observed by Von Gaffron[3] in south-west Borneo, and by Henrici[4] in Central Borneo. It is also the opinion of Verbeek[5] that the gold should be sought in the quartz-veins of the older rocks.

The first proof of the occurrence of gold in the parent rock in W. Borneo was furnished in the Chinese Districts. This region was prospected in the fifties by the mining-engineer, Everwyn, and his investigations were continued and extended thirty years later by Van Schelle.

In N. Borneo gold veins have only been discovered in recent years in Sarawak proper. These have been worked (near Bau). But it has been known for many years that the veins of antimony-ore, which occur here, sometimes contain gold.

In S. Borneo efforts made to find gold in its original place of formation in Tanah-Laut, have not been successful.[6]

---

[1] See R. D. M. Verbeek, *Topographische en Geologische Beschrijving van een gedeelte van Sumatra's West-Kust*, p. 559.

[2] Horner S. 2.

[3] Von Gaffron, S. 27.

[4] Müller, S. 22.

[5] Verbeek S. 41, p. 107.

[6] Javaverslag 1884, II.

The gold is found in veins, and vein-like impregnations, or disseminated through the parent-rock. More exact information, with regard to its occurrence, is only available in the Chinese Districts in W. Borneo, and for this we have to thank the Indian mining-engineer, Van Schelle.

His investigations show that large regular veins, striking over large areas, have not been found in the Chinese Districts.[1]

That they occur is also improbable, according to Van Schelle, as no out-crops have been found.

Vein-like impregnations are the most frequent mode of occurrence. These consist of small veins, threads and nests, occurring like the veins in the clay-slate and quartz sandstone, of the "old slate-formation," or in the older eruptive rocks (granite and diorite).

The gold-veins[2] (*i.e.*, vein-like impregnations) comprise:—

1. Pure gold, *i.e.*, containing no other metal besides auriferous pyrites.
2. Gold associated with copper ores.
3. Gold with copper and lead ores.
4. Gold associated with antimony ores (Sarawak).[3]

Here we must refer to the analogy existing between the occurrence of tin-ore in Bangka, and the occurrence of gold in Borneo. In describing the Diluvial deposits, we have mentioned the close agreement between the tin and the gold deposits on these islands. This similarity is especially remarkable in regard to the occurrence of the ore in its original place of formation. In Bangka there are no true veins, only vein-like impregnations; the tin-ore occuring in small threads, nests, etc. This is known in Bangka as the

---

[1] It is true, gold-veins are mentioned by Everwyn (W. 39, p. 105), as occürring near Madjan, in Landak, in Kosau-pooi, near Budok, in Hang-mooi-sang, near Montrado, and near Mandor. But, perhaps, these were only vein-like impregnations

[2] Jb. v/h. M. 1884, II. 253, 256.

[3] Everett, N. 23, p. 16.

"*Stockwerk*" mode of occurrence; it is identical with the gold occurrence in Borneo (Chinese Districts).

It is further remarkable that in both cases the external layer of rock must have been richer in ore than the parts that now remain; otherwise it would be impossible to explain the great richness of the drift deposits, and the relative poverty of the solid rock.[1]

Gold is found in disseminated particles ("impregnations") in the gabbro and diorite of the upper basin of the R. Sikajam in W. Borneo,[2] and in many places in the weathered slate of the Chinese Districts.[3] In Tanah-Laut too the drift gold appears, according to Hooze, to be derived mainly from the serpentine, mica, and chlorite schists:—*e.g.*, in the Sakumbang mountains. A quartz-vein in gabbro was also discovered.

In the upper basins of the Kahajan and Katingan, gold appears to occur partly in disseminated particles, partly in veins: *e.g.*, the pyrites-bearing vein-quartz of the Mentaweh mountains.

Veins are also found in Tanah-Laut, as is proved by the numerous quartz-fragments in the drift, further in the mountains Pramassan Amandit, where pyrites-bearing veins appear[4] to occur; again in the district Siang-Murong, in the central land, where Henrici found pyrites-bearing vein-quartz on the R. Boboat.[5]

Dr. Schneider reports that in Kutei several pieces of quartz, containing gold, passed through his hands.[6]

The parent-rocks of the gold are the crystalline schists, the Devonian slates, and the eruptive rocks that traverse them.

---

[1] Jb. v/h. M. 1884, II. p. 253, 256.

[2] Very little quartz is found here in the auriferous drift, but much iron-sand and mica.

[3] Jb. v/h. M. 1882, I. 47, and 1884, II. 270.

[4] Ib. 1873, I. 237.

[5] S. Müller, S. 22.

[6] Schneider B. 30.

The age of the gold-veins appears, accordingly, to be partly pre-Devonian partly post-Devonian.

Special Occurrence of Gold in the Chinese Districts.

Skadau Mountains.[1]

In the Skadau mountains, which consist mainly of siliceous schists and clay slates, traversed in places by eruptive rocks, gold-bearing veins have been found on the south-east, east, and south flanks. The veins have no great extent or thickness, the gold occurring chiefly in small veins, in patches, and in threads. The veins are in reality vein-like impregnations.

They occur chiefly in the clay-slates; their strike is mainly south-west and north-east, occasionally, however, east and west. The vein-stuff is quartz, and auriferous pyrites accompanies the gold. The amount is small.

Let us study the veins more in detail.[2]

Three veins were discovered at the south-east foot of the Skadau mountains. One of them consists of quartz, iron-pyrites, oxide of iron (resulting from the decomposition of the pyrites) and kaolin. It has a thickness of 0·3 to 0·4 metre, and traverses clay-slates with a south-west to north-east strike and a dip of 24° to the south-east. The slates have the same strike.

A second vein, not far removed from the first, also consists of quartzose vein-stuff, containing iron-pyrites. It has a thickness of 0·18 metre, and traverses the slates with a dip of 72°. Further, there was traced in the slates a lenticular accumulation of ore, consisting of quartz, pyrites, and clay ironstone. But this was found to have decreased considerably in thickness at a depth of 11·4 metres. A chemical

---

[1] Jb. v/h. M. 1885 I.; 1884 II.; 1885 I.

[2] Ib. v/h. M. 1884, II. 219.

examination showed that the pyrites was auriferous: in the lenticular accumulation it contained 0·0000127 per cent. gold. In the second vein the gold was present in imponderable traces, and in the first vein no gold at all was found.

Near Selinsĕ to the south-east of Teberau, the clay-slate was found to be traversed by quartz-veins; among them a quartz vein 0·11 to 1·12 metres thick, and with a north-east to south-west strike, and a dip of 53° to the south-east. The gold amounted to 34 grm. per ton = 0·0034 per cent. of pure gold.[1]

Near Karangan, on the south-east foot of the mountains there is a quartz-vein striking east and west, and 0·16 metre thick, containing gold and pyrites. This gold is argentiferous. The gold amounts to 97·6 to 136 grm. per ton, or 0·00976 to 0·0136 per cent. gold, and 0·0023 per cent. silver.[2]

Near the river Anau (Sungei Anau) on the south foot, the weathered clay-slate is traversed in all directions by quartz-threads containing gold and iron pyrites. Samples of this gave only a small amount of gold on analysis.

Near Gantung, on the south-east of the mountains, a vein 1·15 metres in thickness traverses the clay-slates in a north-east and south-westerly direction, with a dip of 65° to the north-west. The vein-stuff is quartz. A little gold is present in disseminated grains, together with pyrites in crystals, and nodular aggregates. The gold amounts to 22·0 grms. per ton.[3]

Near Madjau, to the north-east of Ngabong, a thick quartz-vein containing pyrites is said to traverse the slates.[4]

The Udu Mountains.

In the Udu mountains (south-east of the Skadau mountains) at the south foot near Melassan, a vein was followed

[1] Jb. v/h M. 1884, II. 312.
[2] Ib. 1884, II. 313, and 1885, II. 134.
[3] Jb. v/h M. 1884, II. 331.
[4] Everwyn, W. 39, p. 55.

for a distance of 350 metres.[1] This vein, which varies co siderably in strike, dip, and thickness, traverses clay-slate The strike varies from south-east and north-west to sout and north, then south-west and north-east to south-east ar north-west. The dip varies from 45° to 80° to the eas north-east, and north-west. At greater depths the ve increases in size, but soon dies away again; it then divid into a north and north-west branch.

The vein-stone is quartz with disseminated gold ar pyrites; sometimes also bands of clay, containing pyrites a present. In places the country rock is traversed by threa of quartz containing pyrites.

The amount of gold seems to be pretty constant, but places the amount increases. These places have been work by the Chinese. The amount of gold is too small to rep working. It varies from 0·00004 to 0·00005 per cent. go Other samples gave 4 to 5 grms. per ton.[2]

The Pandan Mountains.

The vein-occurrence near Sjui-Tsiët on the northern d clivity of the Pandan mountains is interesting.[3]

The veins here traverse granite in various directions. O of them with a variable, but chiefly east and west, stri (dip = 80° to the south), has a thickness of 0·15 to 0· metres, but it diminishes towards the east to 0·05 metr The quartzose vein-stuff contains, besides gold and ir pyrites, the following copper ores:—copper pyrites, variegat copper ore (erubescite), copper glance, indigo-copper (azurite and here and there some galena. The gold and pyrites occ in lenticles and threads irregularly dispersed through the da grey vein-quartz. The country rock (granite) also contai quartz-threads with iron pyrites and copper pyrites.

---

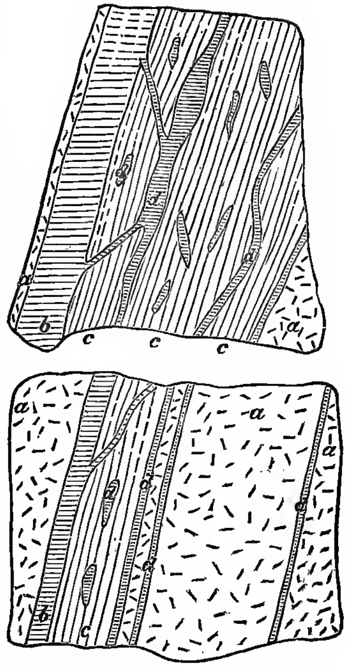
[1] Everwyn 1885, I. 117. [2] Jb. 1884, II. 321, 324, 331.
[3] Jb. v/h M. 1883, I. 5.

The same relations are found to exist in the other two veins, the strike of which, however, is different.

One of them, 0·1 to 0·15 metre thick, consisting of vein-quartz, with iron pyrites and specular iron ore, has a north and south strike, and dips at a high angle towards the west.

The other, 0·51 to 0·55 metre thick, strikes north-east and south-west, and dips 80° to the south-west.

Besides iron pyrites, the vein-quartz also contains copper pyrites, galena and cerussite, the latter occurring in fissures and cracks as crystals four millimetres long, while the crystals of galena attain a length of ten millimetres.



Sections showing gold veins near :—
(*a*) Granite (country rock).
(*b*) Chief vein.
(*c*) Impregnated quartzite.
(*d*) Threads and lenticles of quartz, impregnated with gold and pyrites.

The amount of gold is 17·55 grms. of copper 74·6 grms. per ton ore.[1]

The undressed ore of this interesting occurrence consists of a mixture of copper pyrites and iron pyrites, intermingled with quartz.[2] The gold is finely disseminated through the whole mass. The silver is not confined to the gold, as it also occurs in another compound (probably as a sulphide of silver).

[1] Jb. v/h M. 1883, I. 17.
[2] Ib. 1883, II. p. 168 and 169.

The 100 kilos. of undressed ore were found to contain:—

4·0 Au.
15·7 Ag.
11·34 Cu.

The undressed ore consists of 68 per cent. of ore, and 32 per cent. of vein stuff.[1]

The ore contains:—

11·34	per cent.	Cu.
27·39	„	Fe.
29·12	„	S.
0·02	„	Au. and Ag.
67·87	„	ore.

The vein-stuff consists of:—

1·66	per cent.	Al_2O_3.
30·40	„	SiO_2.
32·06	per cent.	

Various samples[2] gave one milligramme to nine milligrammes gold in 250 grms. of ore, and one sample contained four milligrammes of silver.

In the neighbourhood of Mandor there are similar pyrites-bearing quartz-veins, which contain abundant copper pyrites, and have been worked for gold by the Chinese. (Mine Man-fo-fie and Ko-pie-thew[3]).

Han-Ui-San Mountains.

The vein occurrence in the Han-Ui-San mountains,[4] in the neighbourhood of Mandor is worthy of note.

Here the country rock is a quartzoze sandstone and clay-slate, belonging to the "old slate-formation." The vein traversing it (strike north by east and south by west; dip 85°

[1] Jb. v/h M. 1884, II. 384.
[2] Ib. 1885, II. 135.
[3] Ib. 1878, II. 135.
[4] Ib. 1883, I. 23.

to 90° to the west), has the same strike as the country rock. The thickness of the vein is 1·3 to 1·45 metres. The vein-stuff is quartz with gold and iron pyrites. There are also small veins and nests of iron pyrites in the country rock. The amount of gold is, however, very small.[1]

A similar occurrence is that in the Snaman mountains,[2] near Mandor. The fine-grained quartz-sandstone is traversed by small pyrites-bearing quartz-veins occupying a zone of three to four metres. The iron pyrites is also scattered through the rock.

Near Sikarim[3] the contact zone between the granitic eruptive rocks and the Devonian (?) slates (quartz and clay phyllites), is especially rich in ore. The gold and gold-bearing pyrites occur in the quartzoze vein-stuff in small threads and nests. The amount of silver and gold in the ore is very small. The ore does not repay working.

The vein-occurrence near Budok[4] is also interesting. Gold and pyrites-bearing quartz-veins, of which the biggest has a thickness of 1·6 metres, traverse the slates in all directions. But besides these minerals, there is no inconsiderable quantity of sylvanite (telluride of gold) in the vein. This is the only occurrence of this mineral in Borneo. Everwyn compares it with a similar one in Colorado, in North America.

Near Benkajang or Larah, a vein was worked in 1861, which consisted of quartz, copper pyrites, iron pyrites, "black copper ore," and zinc-blende.[5]

In Sarawak, where gold-veins are worked near Bau, the antimony-bearing veins sometimes contain gold. The gold occurs irregularly disseminated through the vein-stones.

---

[1] Jb. 1885, II. 135.
[2] Ib. 1879, I. 83; and 1868, II. p. 135.
[3] Van Schelle W. 72.
[4] Jb. v/h M. 1879, I. 84.
[5] Ib. 1879, I. 105.

BEHAVIOUR OF THE VEINS BENEATH THE SURFACE.

In the opinion of Everwyn the veins become richer as they descend, as is the case in America. But the investigations of engineer Van Schelle prove the opposite to be the case. Not a single one of the veins examined by him would repay working at any considerable depth. It appeared that only the outermost layer of the rock was rich in ore, and that the richness decreased with the depth.

The richest part of this external shell, or "ore-mantle," is present as detritus in the rich drift deposits; the remaining part (the present outcrop of the veins) has been worked by the Chinese as far as is profitable, and there only remains the deeper rock poor in ore. The same is the case with regard to other ores occurring in Borneo.

GOLD ANALYSES.

Most of the gold contains more or less silver, sometimes also copper.

There are not many new analyses. Gold-dust from the mine Lo-sin-Keeuw, near Selinse, south of Benkajang (W. B.) contains[1] :—

Au.	...	...	86·5 per cent.
Ag.	...	...	7·8 „
Impurities ...		...	5·7 „
			100·00

Vein-gold from Sikarim[2] contained :—

Au.	...	...	82 per cent.
Ag.	...	...	18 per cent.

The best gold is said to be that of Sepang (W. Borneo),

---

[1] Jb. v/h M. 1884, II. 331, and Ib. 86, II. 129.

[2] Ib. 1886, II. 129.

it is much sought after on account of its purity, and its yellow, to reddish streak on the touchstone.

Among the older analyses, Crawford mentions some which we give here[1] :—

<table>
<tr><th rowspan="2">Locality.</th><th colspan="2">100 parts of gold dust contain :</th><th colspan="3">100 parts of the metal contain :</th></tr>
<tr><th>Impurities.</th><th>Metal.</th><th>Gold.</th><th>Silver.</th><th>Copper.</th></tr>
<tr><td>West Borneo:</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Ombak, ..</td><td>3·75</td><td>96·25</td><td>88·19</td><td>8·51</td><td>3·30</td></tr>
<tr><td>Sangau, ..</td><td>4·96</td><td>95·04</td><td>90·97</td><td>3·65</td><td>5·38</td></tr>
<tr><td>Lara, ..</td><td>3·83</td><td>96·17</td><td>86·11</td><td>5·90</td><td>7·99</td></tr>
<tr><td>Pontianak, ..</td><td>14·05</td><td>85·95</td><td>82·99</td><td>16·10</td><td>0·87</td></tr>
<tr><td>Sambas, ..</td><td>9·00</td><td>91·00</td><td>83·68</td><td colspan="2">16·32</td></tr>
<tr><td>Montrado, ..</td><td>12·02</td><td>87·98</td><td>84·09</td><td colspan="2">15·91</td></tr>
<tr><td>South Borneo:</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Banjar-Laut,</td><td>2·66</td><td>96·34</td><td>90·45</td><td>4·34</td><td>5·21</td></tr>
</table>

It is worthy of note that the natives distinguish between two varieties of the gold: namely, young and old gold (*mas muda* and *mas tuwah*). These two varieties can be easily recognised at first sight, for the "young gold" has a more or less brassy tint, while the "old gold" is reddish-yellow, or gold-yellow. The former is rich in silver, while in the latter gold is predominant. The two varieties pass into one another; and the gold varies very much according to the locality whence it is derived.

In addition, the natives distinguish the "diamond-gold" (*mas intan*), *i.e.* gold which is found in the diamond beds; further, "dead gold" (*mas mati*),[2] by which they mean melted gold, or gold that has been in use. It is found at various depths in the ground, in places where, according to tradition, dwellings have stood, which have subsequently fallen into decay. *mas hitam* ("black gold") is also mentioned.[3]

1 Everett N. 23, p. 18. 2 Schwaner, S. 16, I. 98.
3 Jb. v/h M. 1886, II. 128.

GOLD MINING.

Digging by the Natives.

The natives, Malays and Dyaks, confine their efforts t the river-gold and the drift deposits The outcrop of th veins is only rarely touched by them.

The river-gold is the easiest to obtain. In former years i was dug in great quantities, but the diggings are now, fo the most part, abandoned.

This work is chiefly in the hands of the women anc children, who wait till the dry season, when the sandbank of the rivers are laid dry. But they also take advantag of the time when, after heavy rains, the level of the water begins to fall.

The method of gold-washing is that customarily practised The gold-washers stand in the river, and having filled rounc flat wooden dishes (*du-lang*) with river sand, hold them under the flowing water, while imparting to them a rotatory motion. The fine sand and quartz are then washed away while the heavier gold sand, which sinks to the bottom remains behind. The washing is continued until a moderately pure gold is obtained.

The natives also fetch up the gold sand from the bottom o the river bed, as observed by Schwaner in the upper Kahajan river.[1] A small raft is prepared from tree-trunks; at one end is a fascine filled with stones, at the other a small ladder made of branches. With the raft they punt themselves tc the place where the gold sand lies. The gold-washer climbs down the ladder and fills the dishes under water with the auriferous sand, and brings it up to the raft, where it is washed. Then the worker descends again, and repeats the same operation. Even women are occupied in this way.

---

[1] Schwaner, S. 16, Borneo II. 72.

The detrital deposits are also attacked by the natives, but only in a very primitive manner.

Professor Veth states that they use a kind of *Wünschelruthe* (divining-rod), in order to find the spots rich in gold. There is a bird (*Burong soho*) which is said to settle down and to begin to sing on the spots where there is much gold.[1]

They work the hill-detritus (*Bergseifen*), and even the valley drifts (*Thalseifen*), by means of small shafts, especially when they have found the course of the ore in the valley.

They dig holes of one to two metres in circumference, sometimes round, sometimes square.[2] These are often only 0·6 to 0·7 square metre in superficial extent, and of variable depth, according to the thickness of the gold-bed. The hanging-wall, which principally consists of clay, is cast aside until the gold-bearing quartz bed is reached. This is then carried away in the *du-langs* to the nearest stream for washing, a work which is entrusted to the women and children, the men digging the shafts.

If the first hole is successful, others are dug in its immediate neighbourhood, so that a district may become quite honeycombed with such holes. Since the holes lie very near together, and as much as possible of the pay bed is removed, they are generally connected underground; and as the natives pay very little attention to the support of the walls, it often happens that they fall in and bury the workers.

If the first hole proves unsuccessful, the natives leave it, and try their fortune elsewhere.

They have no idea of transporting water; and it is, therefore, essential that their work should be near running water. The richest gold mines are, for them, valueless without this condition.

---

[1] Veth W. 17. [2] Jb. v/h M. 1881, I. 283.

The outcrop of the veins is only exceptionally worked by the natives (Dyaks), *e.g.* near Karangan, Gantung, Selinsé, in the Chinese Districts.[1] The method of working in vogue is very primitive. Near Karangan they followed the vein to a depth of two and a-half to three metres, by digging a shaft. The work was carried on here at intervals. The constantly-accumulating water was bailed out, and the vein-stuff removed by means of a crowbar. Near Selinsé they followed the vein for some distance by means of an adit-level, but it soon fell in, as it was not supported. Near Gantung the vein was worked from above for a distance of twenty-eight metres.

The pieces of vein-stuff removed by the crowbars are broken on boulders of quartz-schist, and arranged in heaps, the larger pieces being broken up a second time.[2] The smaller fragments are usually broken up in the ordinary "rice mills," with wooden stampers.[3] The fine material is worked in the dishes, the white quartz-sand being first removed. The remainder, which consists of quartz-sand, iron pyrites, specular iron, and gold, is again washed, a great part of the gold being obtained in this stage of the process. The remainder is again stamped for a second washing, during which the remainder of the gold is obtained. The stamping and washing are usually performed by women.

The gold obtained in this manner is very fine, the largest pieces having the size of a pin's head. The labour is rather hard, and a part of the gold is lost.

The stone hammers used are worthy of note: they remind one of pre-historic times. They consist of a flat, hard piece of

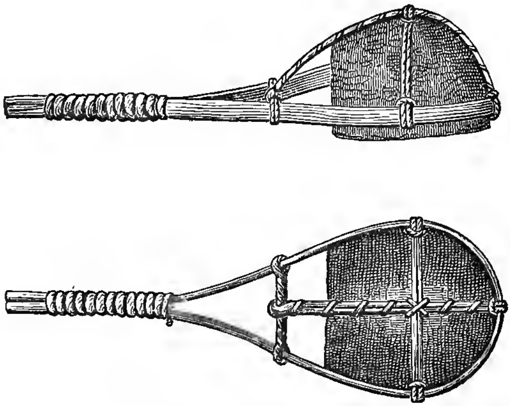
---

[1] Jb. v/h. M. 1884, II. 236, 239, 243.

[2] In the main I follow Van Schelle's description.

[3] The rice stampers used by the natives consist of a log of wood in which a semicircular hole has been made. Into this the rice is poured, and cleaned by stamping.

quartz, tightly clasped by pieces of split bamboo, with cross splits of "rattan" (Spanish cane). The end of the bamboo stick serves as a handle (see Fig.).



Stone Hammer (after Van Schelle).

Digging by the Chinese.

The Chinese obtain gold from the river sand and from the parent rock, as well as from the drift deposits (*seifen*). The main portion, however, is derived from the drift. They do not find gold-washing in the river beds very remunerative; and to work the gold in the parent rock is too laborious for them, and very unsatisfactory, with their deficient technical knowledge: consequently, they devote themselves chiefly to working the drifts, for which their knowledge suffices, and where they obtain the greatest result with proportionally least expenditure of labour.

The great difference between the method of working the drift deposits adopted by the natives and by the Chinese, consists in the fact that the Chinese convey water from a distance to their diggings. Many places rich in gold, are for the natives completely valueless, and in any case a complete exploitation of a digging is not possible; while the Chinese make every gold-bearing place accessible, and at the same time obtain the whole of the gold.

The preliminary investigation of the ground consists in procuring samples by means of a small Chinese borer, while at the same time the position of the gold bed is determined by the resistance and noise made when penetrating the pebble bed.[1]

The *modus operandi* of the Chinese is of great antiquity, and they are, with difficulty, persuaded to make any change.[2]

If they are working a valley drift deposit the first essential is the construction of a water conduit. If there is a brook in the neighbourhood, they lead off from it a canal to the diggings. If there is no stream in the neighbourhood, they will often convey water from a distance of several kilometres. In order to carry out their purpose, they spare neither pains nor money. Valleys are dammed in order to keep back the water, so as to form reservoirs. All the small streams of the neighbourhood are carefully conducted into the reservoirs. Even small hills are removed when they are in the way. If there are lakes within reasonable distance, they are used as reservoirs; sluices are constructed, and conduits leading to the gold fields.

The reservoirs are especially important during the dry season, in the valleys that have no water. In those that have water a sluice (*tebat*) across the whole country is not necessary: it suffices to dam back the river. Both the cost of construction, and the danger of bursting are thus considerably diminished. The highest conduit (*bandas*) serves for washing down the auriferous beds, and for driving the water-wheel. The overflow channel which takes off the superfluous water, is placed as deep as possible, and the two streams of water unite below the mine.

---

[1] Jb. v/h M. 1884, II. 253.

[2] A detailed description of the working in the mines of Lim-Pi-Tu (West Borneo), is given by Van Schelle in Jaarboek v/h Mynwezen van N. J. 1882, I.

The apparatus used by the Chinese is very simple. It consists of the following tools:—

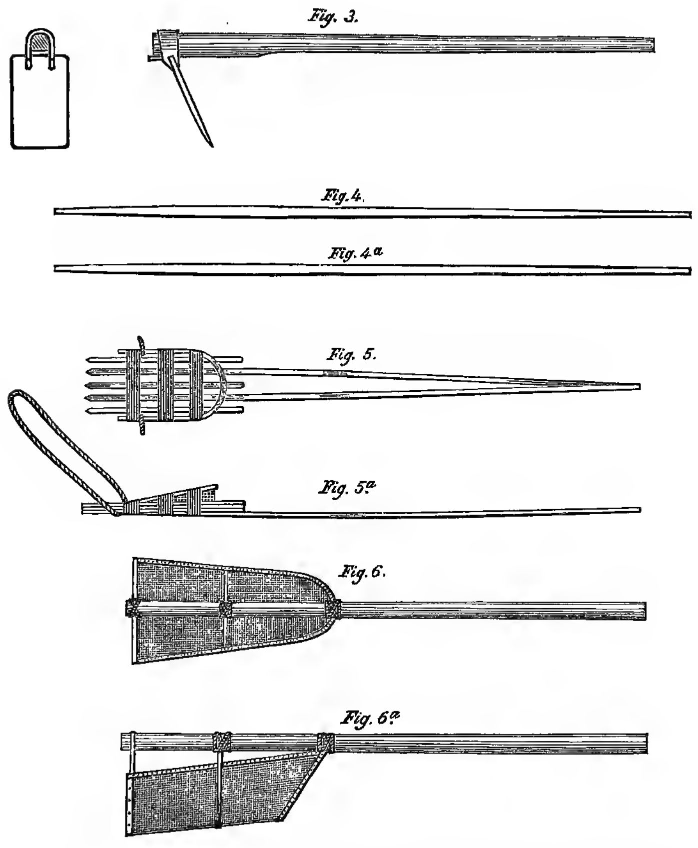


Fig. 3 Shovel; 4 and 4*a* Crowbars; 5 and 5*a* Fork; 6 and 6*a* Washing Baskets.

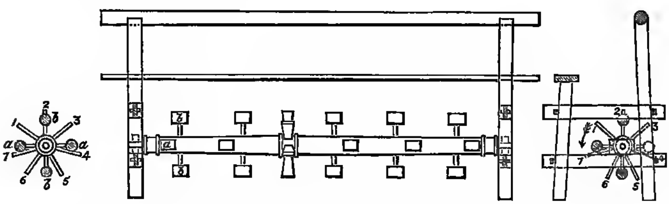
A basket (*Pun-ki*), made of rattan (Spanish cane), used for carrying earth. Usually it is only half-filled, and one man carries two baskets suspended from the ends of bamboo pole laid across the shoulders. The basket will hold from forty to fifty kilograms, and its price is 0·30 to 0·50 florins.

Washing-dish (*du-lang*)—made of wood in different sizes. Price, 1·50 to 3 florins.

Pick (*patjol*)—weight = 2·5 kilogramme, serves both as shovel and spade for loosening the earth. Price, 2·50 to 3 florins.

Crowbar.—A flat bar of iron with steel ends, weighing six to eight kilogrammes, serves for loosening the earth. Price, 6 to 7·50 florins.

Fork (*saki*)—consists of five-pronged head, bound by Spanish cane. The prongs are sufficiently far apart to allow the sand and earth fall through, while the smaller pebbles remain on the fork. The fork is held in a horizontal direction against the stream in the washing canal, and then drawn up by a cord; the larger fragments are retained, and thrown on one side. Price, 0·30 florins.

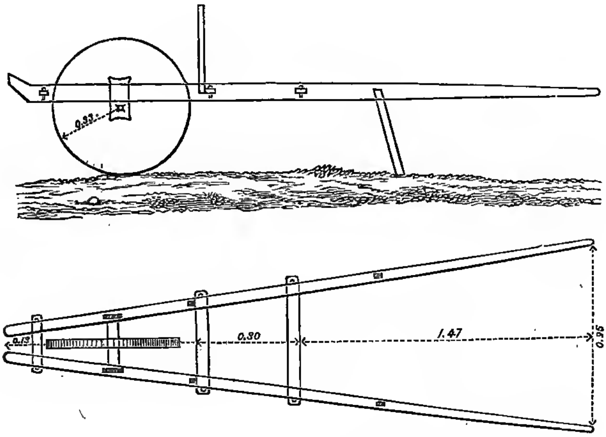


Side view. Chinese Water-wheel (after Van Schelle). Side view.

Water-wheel.—Wooden Chinese chain-pumps are used to remove the water that drains into the mines from above. These are set in motion by over-shot water-wheels. These are quite similar to those used in Bangka, with a few unessential modifications.

The water lifted is ten cubic decimetres per second. The effective power is 24 per cent.

A mine of fifty square metres area and 7·8 metres depth can be kept dry by four chain-pumps (ten to twenty-five metres in length). The great draw-back to these pumps is the fact that when the water is being raised, a part of the empty buckets has to overcome its whole resistance without furnishing any effective power.



Wheel-barrows (after Van Dijk).

The water-wheels have a diameter of 1·5 metres, with twenty-four scoops, and make eighteen to twenty revolutions in the minute. The cost of the chain-pumps and water-wheel is about 280 florins. The water-wheel lasts three years, the pump four.

If there is not sufficient water available to set the chain-pumps in motion, a "Chinese treadmill" is used.

This consists of two boards, united by uprights. The shorter board forms a seat, the longer is used to support the hands. To the lower cross-beam is attached a wooden axis furnished with iron pins. To these are affixed teeth which catch into the links of the chain-pump, and, at the same time, serve as treadles for the workmen.

This work, which costs much time, money, and labour, must first be gone through before the real exploitation can begin.

Kollong Mines (Valley-deposits).

The first mine is always started at the lowest point in the valley at which the ground is likely to repay working: the others always follow *up* the valley. The waste material must be carefully cleared away, as there is no low-lying ground below into which the earth could be washed.

The remaining mines, in the higher parts of the valley are worked as follows:—

The bush is first cut down and burnt. A ditch, generally of the depth of a metre, is then cut through the whole length of the ground to be worked, and the water directed into it. The miners stand on both sides of the canal, armed with crowbars, and push the earth and roots of the bushes into the canal, while others use their spades to undermine the lower part of the earth-wall and bring it to the fall. The rushing water, which resembles a mountain torrent (the work being always carried on in the rainy season), carries everything with it, and fills the abandoned mine below with detritus. Some of the men are stationed below to loosen the accumulating earth-heaps, which tend to dam back the water.

When the ditch has so increased in breadth that the water no longer possesses sufficient strength to remove the earth, its course is changed, or its width diminished. The latter is brought about by erecting in the middle a plank boarding, and causing the water to flow only in the one half, by which its force is considerably increased. By the removal of more earth the canal then becomes broader, necessitating a change in position of the boarding. This is continued until the whole district which is being worked has been lowered about one metre.

This part of the work is termed "washing away the upper beds."

In order now to remove the deeper parts of the deposit a sluice is constructed of boards along the whole length of the district, and the earth is thrown in and washed away. By shifting the sluice from one side to the other side the whole area is deepened. As soon as such a depth has been reached that the miner is no longer able to throw the earth into the sluice with the spade, he fills it into small baskets which are handed up to another workman. Working thus, the sluice is moved, if necessary, across the whole area.

In this way a depth of three metres (including the first metre), can be reached. On an average two men can remove eight kilometres of earth in a working day of nine hours.

If the pay-bed (which sometimes lies at a depth of six to eight metres) is not yet reached, a part of the hanging wall is removed in baskets. Some of the workers loosen the earth with picks; others fill baskets with it, and carrying the two baskets on a pole, take it out to the lower mine, making use of an inclined ladder, constructed out of a tree-trunk in which steps have been cut.

The pay-bed is raised from the mine in the same way. Especial attention is paid to the depressions in the *kong*, which are always rich in gold. If there is not sufficient water available, the ore is allowed to accumulate until there is enough water to begin washing.

When the first claim is worked off, down to the foot-wall, the second is begun, the valueless stuff been thrown into the empty claim. The separate claims are prevented from falling in by timbering.

The work is continued in this way until the mine has been worked out.

When the whole area has been worked down to the bed-rock, the mining campaign is at an end. It usually lasts five to six months.

The washing of the gold-sand, collected up in the ditch, is now taken in hand. The sand is heaped up at the upper end, the ditch is partially dammed by grass, etc., in order to stop the passage of the finer grains of gold; and the flow of the water is diminished.

The lighter material (clay and quartz) is washed away through the sluice into the empty mine. The fine gold-dust also accumulates there, and is, in great measure, recovered by women and children in wooden wash-dishes (*du-lang*). This latter method is also used to recover the gold from the hanging-wall, the amount of which is too little to permit of its being washed in the ordinary way.

The washer fills the dish with gold-sand, and performs the same operations as in ordinary gold-washing. By rotatory and shaking movements he separates the constituents according to their specific gravity. The gold accumulates at the bottom of the dish, while the quartz-sand spreads to the edge, where it is removed by the hand.

By repeating the washing, a purer mixture of gold and magnetic iron-ore (*Puja*) is obtained, the latter imparting to the whole a black colour.

Two sorts are collected—(*a*) moderately pure gold (coarse), often mixed with quartz; (*b*) fine gold, mixed with iron-sand:

The coarser the gold, the easier it is to separate.

The separation of the fine sand requires much time and practice. The gold-sand is warmed in small copper dishes over a wood fire, in order to dry it. Too great a heat gives the gold a red tint. The magnetite is then removed by a magnet, and the purified gold made up into small packets, each weighing two thail=108 grammes.

Sometimes the purified gold is fused with saltpetre and cast in a hollow stone to an ingot. By this process the gold loses seven per cent. of its weight as gold-dust; its sp. g. is then only sixteen.[1]

It is mostly sold in the unfused condition, and the price varies according to its purity.

[1] Jb. v/h. M. 1878, II, 137.

The preparation of gold from sylvanite is carried out by heating the ore with or without saltpetre.[1]

The Kulit Mines (*Hill-deposits*).

These are much more easily worked, as the pay-bed never lies more than three to four metres deep.

In this case, also, a conduit is led to the mine. It must, however, be of considerable depth—down to the level of the pay-bed.

The work is then commenced as in the *Kollong* mines. The earth, including the gold-bed, is broken up by picks and spades, and thrown into the washing ditch, where the gold remains at the bottom, while the clay and quartz are carried away, the larger pieces being thrown aside. By shifting the position of the ditch, as already described, the whole area is worked. The gold-washing begins at the end of the mining campaign.

The working of the Kulit mines is attended with less preparation, trouble, time, and money, than is required by the *Kollong* mines; but the ore is sooner exhausted. A further drawback to the *Kulit* mines is the small supply of water, necessitating the stoppage of the works, often for months during the dry season. This also happens in the case of the *Kollong* mines, but in a less degree, the work being never completely stopped for want of water.

The *Kulit* mines are more suitable for small capitalists.

The size of the *Kollongs* is variable. In 1880, in the mine Sim-Pi-Tu, an area of 3,182 square metres was worked.

The size of the *Kulit* mines varies in a similar way, and this depends chiefly on the amount of water available.

The following data have regard to the miners:—

In the mine Sim-Pi-Tu (W. Borneo), 17,500 cubic metres[2] of ground were worked in the year 1880, by forty men, or

---

[1] Jb. v/h. M. 1879, I. 84. [2] Ib. 1882, I. 43, and 1881, I. 276.

437·5 cubic metres per man.[1 2] One cubic metre contains on the average 640 miligrammes gold, or forty-four miligrammes per kilogram.

In Sjui-Tjiët, W. Borneo, there were, in 1881, twenty-four mines with 255 men. The average output between 1875 and 1881, was 180 thail (=80,000 florins).[3] In the Skadau mountains one shaft often yields 1 to 5 thail=50—250 grammes=70—400 florins.

In a shaft (*Kollong*) of fifteen square metres,[4] 15 thail (=1,000 florins) are said to have been obtained.

Occasionally in washing, one *dulang* will yield 15 to 17·50 florins.

In 1880 a mine near Benkajang yielded 270 thail or 21,000 florins, which after deducting 10,368 florins for expenses, leaves a margin of 10,632 florins.[5]

In the Sebawi valley (W. Borneo) some small mines (0·6 to 0·7 metres in circumference, and three to five metres deep), worked by three men, yielded as much as 3·0 thail.[6]

The mine Sim-Pi-Tu yielded—1880, 207 thail=16,042·50 florins, and a profit of 4,262·50 florins.[7]

In Tanah-Laut Hooze gives the following figures.[8] :—

Per square metre, average yield,	...	0·357 florins.
Per square kilometre royalty,	...	0·17 ,,

On the other hand in good ground:—

	Galumbang Mine.	Rangga Mine.
Per square metre, yield,	0·44 florins.	0·69 florins.
Per square kilometre, royalty,	0·21 ,,	0·20 ,,

In 1884–85 twelve mines in the neighbourhood of Rangga, occupying an area of 18,396 square metres, yielded 20,298 carat gold (at 0·30 florins)=6,089 florins or 0·33 florins per

[1] Jb. v/h. M. 1881, I. 276.
[2] Ib. 1882, I. 43.
[3] Ib. 1883, I. 5.
[4] Ib. 1883, I. 5.
[5] Ib., 1881, I. 276.
[6] Ib. 1881, I. 284.
[7] Ib. 1882, I. 42.
[8] Javaverslag, 1884, II.

square kilometre, and a daily yield of 1·85 florins per man.

In the best mines Rangga, Rinahat, Loa Po, and Sunggei Idjan, the money value of the daily gold-yield per man was 3·70, 3·58, 2·47 and 1·74 florins.[1]

A sample of 1,572 cubic metres of diamond-earth near Bentok-Martapura, consisting of gold, platinum, magnetite, ilmenite, and chromite, contained 0·031 grammes pure gold.

A similar sample from the mine Hinot, near Pontein (Tanah-Laut) contained 0·0006 per cent. gold.[2]

The drawbacks to the Chinese method of work are various. The manner of loosening the ground, especially the deeper and more compact material, by means of picks and spades, is very slow and wearisome, and the work would be much simplified by blasting with dynamite, as already suggested by the mining engineer, Van Schelle.[3]

Much time and labour is wasted in raising the ore from the mine to the sluice. Small trucks or a "pater-noster" arrangement would be a great improvement.

Further, the gold washing in the sluice is primitive, and a part of the gold is lost (how much is not exactly known).[4] This is proved by the supplementary washing of the women and children, by which a part of the gold is recovered. By the use of mercury in the sluices, the fine gold could be amalgamated.

But the chief drawback is the frequent scarcity of water, in consequence of which nearly every year the work has to be stopped for some weeks or even months, during the dry season. This could be partially remedied by the construction of reservoirs.

---

[1] Javaverslag, 1886, II.

[2] Jb. v/h. M. 1884, II., 318.

[3] Jb. 1881, I., p. 280.

[4] This loss on tin-sand in Bangka varies from 1¼ to 8 per cent.

On the other hand, the work is also sometimes retarded by too much water.

The appearance of a deserted mining district is described by Schwaner as one of complete desolation.[1] The district is covered with sand and stones, the numerous diggings being filled with water, are converted into small swamps; the vegetation is completely extinct, and many years are required to restore its natural covering of vegetation to the wilderness.

Gold-mining in the parent-rock by the Chinese.

The Chinese also work the auriferous veins—chiefly along their outcrops. But they also follow the vein by levels and shafts. Their insufficient knowledge does not permit them, however, to exploit the veins for any distance, for either the level or the shaft falls in, in consequence of imperfect timbering. They have also to deal with infiltrating water, which the Chinese can only overcome to a depth of eight to ten metres.[2] As they have no idea of boring or blasting, they break away the vein-stuff with crow-bars, and reduce it to small pieces by hammers. The small fragments are then crushed in a mortar of granite or sandstone, which they obtain from China, and the gold is finally washed in pans.

By this rough method of working one-half to two-thirds of the ore is lost.[3] That the outcrop of the veins must have been very rich is shown by the fact that they have been worked for years by the Chinese. The many abandoned mines and the levels which still existed in the eighties prove that the Chinese worked a great number of the veins.

In the Skadau mountains clay slates traversed by quartz-thread and small veins, are worked, near Teberau, by the Chinese to a depth of 2·5 metres. The main vein is said to have been 0·8 to 1·0 metres in thickness.[4] In the eighties,

---

[1] Schwaner S. 16, p. 68

[2] Jb. v/h. M. 1879, I. 107, 108.

[3] Ib. v/h. M. 1879, I. p. 107, 108.

[4] Ib. 1884, II.

a level, fifteen metres long, was worked near Silensé. It finally collapsed on account of imperfect timbering.

Near Sungei Anau the outcrop of a bed of slate traversed by a network of small veins was worked to a depth of five to seven metres.

Near Melassan,[1] in the Udu mountains, the richer parts of of a vein were worked in the beginning of this century. The work was stopped by the increase in depth, the accumulation of water, and the hardness of the stone.

The same is the case in the Pandan[2] and Han-Ui-San mountains. In the Snaman mountains the Chinese had opened up a bed of sandstone, impregnated with pyrites and traversed by small veins to a depth of six metres, and had worked it from above for a distance of sixty metres.[3] Similarly a vein was worked in the fifties near Bundok, and also near Montrado, to a depth of fifteen metres.[4]

The greatest depth was worked near[5] Madjan, namely eighteen metres.

Gold-mining by Europeans.

It has already been mentioned that gold and diamonds were begun to be worked in the eighties by a company in S. Borneo. (See Historical Part.)

Also in Sarawak[6] the Borneo company worked gold veins; and in Sabah rich auriferous gravels were worked on the river Segamah.

GOLD-SMELTING.

Since the earliest times, the natives have understood the art of smelting. As it possesses several peculiarities, I will describe briefly how it is carried out in Teweh (5′ South of the Equator), in Central Borneo.

---

[1] Jb. 1885, I. 117.
[2] Ib. 1883, I. 9.
[3] Ib. 1879, I. 40.
[4] Ib. 1879, I. 83.
[5] Ib. 1879, I. 56.
[6] Everett, N. 23 and notes.

The chief peculiarity in the method is the use of a bellows. This apparatus consists of a box about forty centimetres long, twenty centimetres wide, and fifteen centimetres high, made of wood, and with a cover which can be rendered air-tight by means of a cloth. On the two shorter sides of the box are valves, opening inwards, for the admission of air. In the upper part of the box is a second compartment, also furnished with two air-holes. The opening and shutting of the valves fills the larger box with air, which streams thence into the smaller box, and is conducted into the fire-place by means of a brass tube. The construction of the piston is noteworthy; it consists of a thick piece of wood, made air-tight by means of hen's feathers. The valves are thin pieces of wood.

The hearth consists of a square wooden box filled with clay. Above this is the smelting hearth, separated from the fire-box by two bricks. The tube which conducts the air communicates with a hole in one of the bricks. The gold which is to be fused is placed in a clay crucible. The fuel is charcoal.

Usually the gold has to be smelted twice in order to give it the required ductibility.

The natives also make use of a burnishing stone. From the colour of the streak made on this, they can tell whether the amount of gold is large or small. By smelting together the different varieties of gold, they are able to obtain the desired mixture; in this experience plays a great rôle.

Social Arrangements of the Chinese Miners.

In general there is a great resemblance between the Chinese miners in Bangka (tin-washers) and those in Borneo. The only difference is that in Bangka the mines are the property of the government, while in Borneo they are rented by the miners themselves. In Bangka the miners are under the control of mining engineers, who determine by trial-borings the best position for the mine, and bring their technical knowledge to bear on the question of water-supply. The government also supplies the miners with food at a low price, and makes them advances of money in times of need. But in return the miners are bound to hand over the tin at a fixed (low) price to the government, who sell it at a great profit (eighty to a hundred per cent.). In Borneo the miners have nothing to do with the government: they are not supported by it; and can dispose of the gold to whomsoever they please.

In order to work a mine in Borneo a number of miners form a union (*Kongsie*), and after the preliminary investigations have been made, seek to obtain a concession from the European officials. It has become more difficult to obtain good ground than was formerly the case, as the best places have already been exploited, and according to the new laws (1862), no more ground in the neighbourhood of villages may be devoted to mining purposes.[1]

Consent having been given, a license to dig for gold is obtained for the sum of one florin per month and per worker, and then the work begins.

The number of unions (*Kongsie*) is pretty large, and the number of members varies greatly according to the size of the mine. Besides the shareholders (*Hun*) who participate in the gain or loss there are also day-workers (*Kuli-kongsie*), who work[2] at a fixed rate, and the number of which has increased lately.

If the shareholders do not themselves work in the mine, they must provide substitutes (*Kuli-hun*).

If the members of a union possess sufficient capital, they put enough together to commence the expensive preliminary

---

[1] Jb. v/h. M. 1881, I, 269.

[2] In 1880 the monthly wage was twenty-two florins in the mine Sim-Pi-Tu; this is made up of the items—money 14 florins, rice 4.50 florins, and other things 3.50 florins. (Jb. v/h. M. 1882, I. 43.)

works. (Erection of water-works, purchase of tools, construction of huts, etc.)

When the gold is washed, the gain is divided in proportion to the capital invested. But it often happens that the members have to borrow money at a high rate of interest (twenty-four to thirty-six per cent.), from a few rich Chinese, binding themselves thereby to pay back the sum borrowed, together with the interest, when the gold-washing takes place.

The creditors always take care to be present at the gold-washing. If the year is favourable, the debts can be paid, and a residue accrues to the union. In this case the co-operators often do not use their money for a fresh venture next year, but prefer to borrow again for that purpose. If the amount obtained by washing turns out smaller than was expected, the mine gets deeper into debt. The userers continue to make advances, but under harder conditions, demanding also some of the shares for themselves.

If the mine is unable to pay again in the next year, the members usually become bankrupt and decamp. The usurers who generally have recovered their capital, now take possession of the shafts, and endeavour to set another union going.

The miners choose, yearly, their own chief (*Kapala-parit*= mining captain), to whom is entrusted the superintendance of the works. He is assisted by a cashier and a store-keeper.

It may be assumed that only seventy-five per cent. of the men really work in the mine; the others have special duties as carpenters, smiths, cooks, gardeners, and swine-herds. The latter duties are generally entrusted to the old and others who are in any way unfit for work.

The work lasts the whole day, with five intervals, which are set apart for meals. Lazy workers are punished by a reduction of their pay; a reduction is also made in the case of sickness.

The daily necessities—tobacco, clothes, etc., are purchased by the union of the nearest traders, but usually at a very dear rate. If the trader also lends money, the union is often obliged to borrow their requirements from him at an extreme rate of interest.

The mine-buildings have everywhere the same appearance. On approaching you see four buildings standing at right angles to one another, enclosing a large court-yard. These erections are built of boards. The foremost contain a number of benches and tables; around which the miners congregate five times a day to partake of their meals, and to spend their spare time in the evening. The back part of the building is the "Kongsie-house," divided into three parts. In the middle part is the image of the good god (Tay-Pekkong), surrounded by candles and gifts. It is here that the officials and guests are received. On the one side of this division is the dwelling of the cashier and of the store-keeper, on the other side the store. Both buildings at the sides serve partly as kitchens, partly as dormitories for the unmarried workers. The married ones live in their own houses. In the court-yard, not far from the main-building, is a little miniature house for the wicked god. Gifts are heaped up before the latter, often more than before the good god; for the cunning Chinamen think that the good god will not in any case hurt them, and that it is only necessary to propitiate the bad god, in order that he shall not spoil the prosperity of the mine.

Every mine has a vegetable garden, a rum distillery, and a pig-sty, the latter being kept in a state of cleanliness unknown to European pigs.

In the mine Sim-Pi-Tu, during the mining campaign of 1880, the following expenses were incurred:—[1]

	florins.
Purchase of materials and maintenance,	1,000·00
Rent, ...	552·00
400 Pikols of rice, ...	2,500·00
Wages, ...	7,728·00
	11,780·00

[1] Jb. v/h. M. 1882, I. p. 42.

	florins.
207 thail at 77·50 florins were obtained,	16,042·50
Total expenses, ...	11,780·00
Gain, ...	4,262·50

On each share, 90 florins.

These arrangements are not very favourable for the development of the gold-mining. Large deposits cannot be worked on account of lack of capital; and a single unfavourable year suffices to ruin a mine financially.

Francis[1] gives, in the beginning of the forties, the following data with respect to a large mine :—

Expenditure:—

	florins.
Two writers (yearly wage), ...	384
Two overseers do	768
125 labourers (at 16f. per month), ...	22,800
Maintenance for 129 men (at 9f. per head),	13,932
For dwelling and tools, ...	5,000
	42,884

Income :—

600 to 800 thail at 64f.=38,400f. to 57,604f.

GOLD-PRODUCTION.

Dutch Borneo.

Unfortunately we do not possess exact data with regard to the out-put of gold. We only know that the most flourishing period was at the end of the previous and at the beginning of the present century; that in the beginning of the fifties it had already considerably decreased, and that this decrease has continued down to the present. Of the states on the east coast, which are nominally under the rule of the Dutch, but in reality are nearly independent, we

[1] Francis W. 3.

know scarcely anything. We have to content ourselves mainly with the vague reports of the natives, which are not always deserving of full credit, and appear to be exaggerated. We only possess a few data with regard to the gold out-put in W. and S. Borneo, and it is in these districts, and more especially in W. Borneo, that most of the gold appears to be obtained.

This has a natural cause.

The gold seekers in S. and W. Borneo are, in most of the districts, under regulated Dutch rule, which affords them protection; while in E. Borneo they are completely exposed to the arbitrary will of the native rulers. The natives, who only dig gold on a small scale, have, in these states, to suffer many extortions, so that a great part of their gain is taken from them, which is, of course, detrimental to their industry.

The Chinese have suffered much. Attracted by the reports of the richness of these districts, they betook themselves there to dig for gold. But, finding themselves entirely exposed to the despotic will of the native princes, who looked upon them with no friendly eyes, they preferred to abandon their settlements, leaving the gold-digging entirely in the hands of the few natives who, in spite of the oppression, continued the work. In Solo, and in the peninsula Unsang (W. Borneo), the Chinese had begun in the forties to work mines; but they were compelled, by ill-treatment and murder, to leave the district.

It is otherwise in S. and W. Borneo. There the gold-seekers are protected by the Indian government, and their gain, with the exception of a small tax, is entirely their own. Consequently, the Chinese streamed hither in great numbers, and especially to W. Borneo, where they constituted the above-mentioned powerful mining unions.

From the Chinese miners we have obtained no information, as they—like all business people—keep their gains as secret as possible, and always speak of the bad state of business, or of their losses, in order to keep their taxes as low as possible, and to prevent others from settling down in their districts.

Another custom of the Chinese is to burn their books at the close of each business year, so that they themselves forget the exact details after the lapse of some time. Again, their administration is complicated; they strike no balances, and easily withdraw themselves from the control of the European officials, who are unacquainted with their language and writing.

It is also difficult to determine the production of the gold by that which is exported, as much of it is sold in the interior. From these causes there is relatively little value to be attached to data concerning the gold export, and the mining engineer, Everwyn, stated, as early as 1853, at the time of his investigations in W. Borneo: "That we can only be certain of one thing, namely, that the gold out-put is rapidly decreasing."[1]

Equally unreliable (and from the same causes) are the accounts given by the natives, who, however, never obtain gold in considerable quantities.

The best way of judging of the gradual decline of the gold out-put is, perhaps, by comparing the number and distribution of the former gold mines with those at present in existence.

According to Horner,[2] there were, in 1836, near Gunong Lawak, in Tanah Laut (S. Borneo), over 200 gold and diamond mines, with 3,000 to 4,000 washing places. A Chinese miner could earn annually five to six thail = 3,400 florins, and a native about 100 florins, or 0·30 florins per day.[3]

---

[1] Jb. v/h. M. 1819, I. 10.

[2] L. Horner, S. 2.

[3] In the eastern part of Tanah-Laut nuggets of gold, weighing eighty grammes, were frequently found in the twenties; and a working of 1,000 square miles area, and twenty-five to thirty feet depth, furnished 20,000 Spanish piastres. (T. v. W. J. 1838, I. 409).

According to Von Gaffron's calculations, a miner in the rich gold-mines near Pontain, could, in a day of six to eight hours, earn 5·20 florins. He estimates the monthly yield of these mines at 19,000 florins.[1] According to Horner 60,000 to 70,000[2] florins worth of gold were exported from Bandjermassin in 1834.

In former years much gold was washed by the natives in all the river basins of S. Borneo.

In the river Barito, gold was washed near Bekompai (Marabahan), and at other places up-stream. Thus, near Buntok, in the neighbourhood of Kampong Trussan, above the river Ajo,[3] in the sandbanks of the district Dusson Ulu,[4] in the district Siang-Murong. Gold was also washed in most of the tributaries of the Barito, and in the rivers which take their source in Tanah-Laut.

Gold was also washed[5] along the whole length of the river Kapuas to Kotta basarang, within a short distance of its mouth, as well as in the tributary rivers, where pieces weighing twenty grammes have been found.

In the river Kahajan gold is washed as far as Muara Rawi and especially in the tributary streams Rungan and Menohing. Nuggets from eight to ten cubic centimetres often occur here, especially in the river Maratja. Near Muara Rawi a gold-washer is said to have earned 0·60 florins daily, and twelve miles further up-stream one florin per day. But the gold-mines furnished one to two florins per day. Maks[6] also states that the upper course of the Kahajan, and its tributaries (among others the Sungei Marikooi, S. Pasangon, S. Panjeharen), as well as the surrounding district must be very rich in gold. A Dyak, even with his primitive

[1] Von Gaffron, S. 27.
[2] Horner, S. 2.
[3] Schwaner, S. 16, Borneo I. p. 104 & 109.
[4] Ib. S. 16, Borneo, I. p. 154.
[5] Ib. S. 16, Borneo II. p. 46.
[6] Maks S. 24, p. 21 and 27.

methods, often gains two to three florins daily, and the annual yield is said to be about 12,000 florins. Gold-washing was also very common in the river Katingan, and in the remaining streams lying to the west of it.

At the present time gold-washing has almost entirely ceased in Tanah-Laut, and in the basin of the Barito. It is not nearly so remunerative as formerly, and the natives, being able to earn more money by other work, have given it up. With regard to the other river-districts, we have no information.

In E. Borneo gold was dug in the forties in the state Kusan,[1] to the amount one-fourth gantang[2] annually; in the district Pamulawan, one-eight gantang; and in the basin of the Sila and Sililau, one-fourth gantang. During the same years 300 to 400 thails were obtained in Passir, and sold to the Sultan for twenty reals.[3]

No mention is made of Passir; it would seem, therefore, that gold is no longer being dug there.

According to Hooze's report (in the eighties) there were thirty-eight mines (*parit*) being worked in Tanah-Laut; among them three rich mines lying at the foot of the Meratus mountains (Hinot, Tikup, and Sungei Pinang). On the average the daily gain was 0·80 to 1·22 florins; on better ground it rose to 1·83 florins and 2·26 florins.[4]

In W. Borneo a considerable decline was visible as early as the beginning of the fifties.[5]

In the Snaman mountains, in the Chinese districts, there were at this time still many gold mines and gold-washing places.[6] In the neighbourhood of Budok, Benkajang, and

---

1 Weddik, E. 3.
2 One gantang = one-tenth Pikol = 6·2 Kilogramm.
3 Weddik E. 3. Gallois, E. 9.
4 Neuwknyk E. 12.
5 Verslag 1884, II. and III.
6 Jb. v/h M. 1879, I. p. 10.

Montrado, on the other hand, many of the numerous mines had been already abandoned.[1]

In 1854 there were only a few mines left in Landak, the largest being the mines near Madjau, with forty workers. But the honeycombed nature of the ground showed that there had formerly been many more here.

Near Mandhor there were many rich mines, with 100 to 300 miners, in existence at the beginning of the century, and during the gold-washing season (three to four months), 200 to 250 thail gold were always obtained. The Ontaroh brook (R. Landak) is said to have been so rich in gold, that a bungkal of gold (=24 to 25 Spanish matten) could be obtained in ten days.

In Sambas, during the forties, nuggets of gold up to twenty thail (800 grms.) were found. A mine usually produced 210 thail[2] (21·000 florins) annually: a large mine 600 to 900 thail (38,000 to 58,000 florins).

In 1856 there only remained five mines, with thirty to forty men. The gains of these were small, as the best ground had already been worked.

In 1860, eleven thail gold (770 florins) were obtained in a mine near Theu-Thu-Kong, in six months; the profit amounting to 238 florins.

In 1861, only four thails were obtained from the same mine; just enough to cover the costs of working.[3]

In Sukadana the Chinese settled about the year 1825 in the neighbourhood of the Melaju mountains, in order to dig for gold; but they abandoned the neighbourhood two years later on account of the smallness of the profit.[4] In 1845 twenty Chinese settled in the neighbourhood of Abut for the same purpose; but ten years later their number had been reduced to five men by the same cause.[5]

---

[1] Jb. 1879, I. p. 50, 83, 34.
[2] Jb. v/h I. 1879, II. p. 385.
[3] Jb. v/h M. 1878, II. p. 135.
[4] Jb. v/h M. 1879, I. 68.
[5] Jb. v/h M. 1879, I. 68.

In the basin of the R. Kapuas there were formerly numerous mines. Thus in the twenties there were over fourteen gold mines, with 470 Chinese miners in Sanggau. In Skadau there were, in the forties, seven mines, with 290 Chinese; in Sintang, twelve mines with 100 Chinese.[1]

In 1850 the number of gold mines in Tajan was thirteen; in Meliau, two; in Sanggau, twenty-one; in Skadau, seven; in Spau, one; in Sintang,[2] twenty-one; in Silat,[3] five. The Prince of Bunut is reported to possess a piece of gold as large as a small man's hand.[4]

In the basin of the R. Melawi, the daily yield in gold-washing on the R. Serawai was, in the forties, one florin, but occasionally it rose to four florins, and a gold mine usually produced 400 to 600 florins.[5]

Thus formerly there existed numerous and more or less prosperous gold mines.

In the eighties gold was still being dug in all parts of W. Borneo, excepting the districts Pontianak and Sungei Kakap, which do not contain gold. But the produce was extremely small, and only that of the Chinese districts is still of any importance.[6] Most of the mines are in Montrado, Sambas, Mandor; in Mampawa there is only one, in Landak several; in Sinkawang there is only gold-washing. In Sukadana gold-digging seems to have ceased completely.

There are a few mines in Tajan on the R. Kapuas; also in Sanggau, near the R. Aja. Most of the mines on the upper river Sikajam are already abandoned. In Spauk, gold is only dug by the Dyaks. In Sintang there are still a few mines along the Kapuas, also along the river Melawi. In

---

[1] T. v. N. J. I. 1849, I. 338.

[2] The Chinese miners, in the forties, paid the Prince of Sintang a yearly tribute of ten to fifteen bungkal gold (Borneo II. 199).

[3] V. Lynden W. 11.

[4] Gerlach W. 45.

[5] Schwaner S. 16, Borneo II. 145, 178.

[6] Jb. v/h M. 1822, I. 46.

the upper basins of the Kapuas and the Melawi, gold is only sought for by the natives (Dyaks).

North Borneo.

Sarawak.

In Sarawak the annual export is said to have been about 7,000 ounces = 252,900 florins in the forties.[1] In the year 1854 it was estimated at 150,000 Spanish matten.[2]

We have only exact statistics from the year 1864.[3]

1864	...	9,482 lbs.	...	309½ Bungkal.
1865	...	5,394	...	192·5
1866	...	2,250	...	75·0
1867	...	6,998	...	233·0
1868	...	890	...	29·5
1869	...	14,238	...	574·0
1870	...	5,879	...	193·3
1871	...	4,952	...	165·0
1872	...	7,484	...	226 7
1873	...	6,263	...	189·7
1874	...	745	...	15·7
1875	...	424	...	10·5
1876	...	504	...	16·5
1877	...	675	...	20·5
1878	...	1,730		
1879	...	2,258		
1880	...	3,663		
1881	...	2,918		
1882	...	1,380		
1883	...	234		
1884	...	8,621		
1885	...	21,754		
1886	...	28,281		

[1] Low N. 1.
[2] Veth W. 17, p. 326.
[3] Everett N. 23, and communications by letter.

Brunei.

No gold is found in Brunei.

Sabah.

In Sabah, a gold-field recently discovered in the R. Segamah, is begun to be worked, but there are no details to hand.

The few older data available with regard to the gold produce and export are the following:—

A gold-trade is said to have existed in Borneo as early as the thirteenth century. In 1780 most of the mines were being worked; according to Tobias the gold was not weighed but measured. According to Raffles, the produce in W. Borneo had in 1812 a value of 4,744,000 Spanish matten, = 189,000,000 gulden;[1] according to Crawford, however, its value was 1,669,058 Spanish matten, = 88,362 ounces of gold. Others[2] value the produce in W. Borneo at 4·7 to 6,000,000 piastres, the produce being placed at 200 pikol gold. In 1823 Tobias estimated the export at 80,000,000 gulden (= 2,000,000 Spanish matten).[3]

In 1848 the exported gold amounted to 1,349,814 florins, of which 1,289,580 florins are assigned to W. Borneo, and 60·280 florins to S. Borneo.

In the forties the annual export in S. Borneo was as follows:—

From the basin of the—

Kapuas,	120,000 florins,	—	3,000	ringit per ½ thail.
Kahajan,	320,000 „	—	6 to 8,000	„
Katingan,	40,000 „	—	1,000[4]	„

[1] Jb. v/h M. 1879, I. p. 10.
[2] T. v. N. J. 1850, II. 163.
[3] Veth W. 19.
[4] Schwaner S. 16, Borneo I. 155; II. 113, 143.

This produce, however, might have been largely increased; for although gold-digging is the chief employment of the natives, they only wash as much as is absolutely necessary to supply their wants, and only this in the immediate neighbourhood of their dwellings, as they are prevented from going further abroad by the fear of their enemies.[1]

Exact details are only available for the eighties with regard to the Chinese Districts and Tanah-Laut, the two principal gold districts. These data were collected at the time of the geological and mining survey.

The gold produce in the Chinese districts is shown in the following Table. The Chinese mines are alone taken into consideration, and the calculation is based on the rental. The produce of the gold-washers could not be estimated, as it is unknown, and no rental is paid. In 1882 it was fixed approximately at 160 thail = 11,000 to 13,000 florins for Montrado (corresponding to a daily gain of 0·30 to 0·40 florins per day).[2]

Annual produce (average) 1880-1884 (inclusive), = 159 kilogramme of a value of 219,000 florins. These official figures are too low.

Between 1871 and 1879 the export was 1,097,708 florins, the annual average being 211,088 florins = 2,706 thail.

Price of the Gold.

The price of the gold varies from time to time, and has risen since the eighties.

A thail[3] has the following values:—

In 1836 in Martapura (S. Borneo) from 50 to 62 florins.[4]

---

[1] Ib. S. 16, Borneo II. 69.

[2] Jb. v/h M. 1884, II. p. 298.

[3] In Borneo only the word *thail* is used. One *thail* = two Spanish *matten* = 54 grm.; according to Schwaner, in the forties, 46 grm. (S. Jb. v/h M. 1879, I. 56, and Ib. 1882, I. 49). One *bungkal* = two *ringit* = one *thail* (Borneo II. 196) one *real* = two florins (Jb. 1879, I. 56).

[4] Horner S. 2.

ABSTRACT OF GOLD PRODUCTION IN MONTRADO AND SAMBAS (WEST BORNEO) 1880–1886.

Year.	Workers.						Gold Seekers.(1)			Total No. of workers	Total production	Total Money Value.	Production in kilogrms.	Rental.	Value (2) of the Gold exported.	Production per head in gulden.
	No. of Mines.	Shareholders	Coolies.	Total.	Production in thail (=34 flors.)	Money value of production	Number.	Production.	Value of production.							
1880	111	753	76	829	2,289·5	171·772	271-36)	691	53·616	1,145	2,980·5	225·338	166·909	11·088	168·820	196·80
1881	114	763	99	862	2,231·0	171·772	380	907·5	67·885	1,242	3,138·4	239·502·5	175·756	11·064	49·800	193·64
1882	111	700	104	894	1,734·5	171,617	375	528·5	?	1,269	2,263	172.002·5	126·728	7,896	121·890	135·54
1883	113	787	113	200	2,187	?	418	111·5	—	1,318	3,302	249·6 8	178·308	9,324	33·200	183·44
1884	108	777	102	879	1,959	—	363	801	—	1,242	2,760	208·296	149·040	8,436	56·160	167·71
1885	109	772	81	853	2,005	—	371	820·5	—	1,224	2,825·5	209·082	152·770	8,904	48·600	175·25
1886	107	690	95	785	1,636½	—	278	635½	—	1,063	2,272	f.155·200	122·688	8,675	?	146·00

[1] These are workers who are not regularly employed in mining, but only at times, and then only work in the *kulit* mines, or at gold-washing.

[2] This statement is not quite accurate. Only the larger amounts are given. Gold is also taken overland by way of Sarawak, nine-tenths of it goes to Singapore.

In 1848 in Melahui (W. Borneo) from 40 to 50 florins.[1]

In 1849 in Passir (E. Borneo) from 40 florins.[2]

In 1850 in Kusan (E. Borneo) from 40 florins.[3]

In 1856 in Mandhor (W. Borneo) from 39 to 65 florins.[4]

In 1756 the price was fixed by contract in Bandjermassin at twelve Spanish matten.

In 1831 it was seventy-seven to eighty-four florins in Pontianak, according to Gronovius.

At the end of the eighteenth century a thail of gold equalled twelve ringit. In Sarawak,[5] in 1874, the price varied according to the locality.

From	Bau,	28	pounds were received per Bungkal.[6]		
„	Kiladi,	30–32	„	„	„
„	Paku,	28–29	„	„	„
„	Gumbang,	28	„	„	„
„	Siku,	28	„	„	„
„	Serin,	98	„	„	„
„	Marup,	30–32	„	„	„

The present prices vary according to the chemical and mechanical purity of the gold. The mechanical impurity is magnetic iron-ore; the chemical impurity is due to the presence of much silver or copper.

Gold from Mandhor contains copper and silver, and consequently does not obtain a high price.

Argentiferous gold is derived from Benkajang, Budok, Karangan, in the Skadau mountains, and Sjui-Tsiet in the

[1] Schwaner S. 16, Borneo II.

[2] Weddik E. 3.

[3] Ib. E. 3.

[4] Jb. v/h N. 1878, II. 137; Ib. v/h M. 1879, I. 56.

[5] Denison N. 18.

[6] According to this statement a *bungkal* = ¼ *thail* = 10 grm.; seven pounds per *thail* = 84 florins, on an average also seven to eight pounds per *thail* = 80 to 100 florins. It has already been mentioned that gold is sold in the unmelted state.

Padan mountains near Lumar.[1] The purest gold, and that most sought after comes from Sepang. On the touch-stone it gives a good red streak.

In W. Borneo the present price varies from seventy-five to eighty-one florins per thail, or 1,390 to 1,500 florins per kilogramme, while the argentiferous ores may be obtained at less than seventy florins per thail.[2] In Kusan (E. Borneo) the price of a thail is 62·50 florins.[3]

Use of the Gold by the Natives.

That Borneo is rich in gold is a fact forced upon the stranger by the quantity and variety of ornaments worn by the natives. These are skilfully made by native gold-smiths, who are to be found in every district. The luxury in articles of gold is especially seen among the rich natives and Chinese; but it reaches its height in the sultan families. The former Sultan of Martapura (S. Borneo), is reported to have possessed a small golden lilla (cannon); and another of fifty katti weight is in the possession of the Sultan of Gunong Tabor (E. Coast).[4]

According to Schwaner and Von Gaffron, gold was much used as currency by the natives in the interior during the forties.[5]

Similarly gold was used as a means of exchange in the upper basin of the Kahajan and on the Katingan, where gold is measured and weighed.

Weight of the Gold.

The following standard of weight exists, according to Schwaner, in the upper basin of the Kapuas (S. Borneo).

The greatest weight is a ringit = ½ thail = 20 florins.

---

[1] Jb. 1879, I. 83.
[2] Ib. 1882, I. 49.
[3] Nieuwkuyk, E. 12.
[4] Von Dewall E. 6.
[5] Schwaner, S. 16, Borneo I. p. 155, II. 196.

The smaller weights are :—

Sa Djampal	=	$\frac{1}{2}$ ringit	=	10	florins.
Sa Kopang	=	$\frac{1}{5}$ ringit	=	2	„
Bun Kaju	=	$\frac{1}{10}$ ringit	=	2	„
Buntong	=	$\frac{1}{20}$ ringit	=	1	„
Sa Tilai	=	$\frac{1}{40}$			
Stali	=	$\frac{1}{30}$			
Brini	=	$\frac{1}{120}$			
Mata Burong	=	$\frac{1}{240}$			
Bua Bakong	=	$\frac{1}{480}$			

In Melahui (W. Borneo), the following standard is used:—

1 Bungkal = 1 ringit = 1 thail = 40·50 florins.
1 Bungkal = 18 amas.
1 amas = 2 Djampul.
1 Djampul = 2 Suku.
1 Suku = 2 Stali.
1 Stali = 3 Uwang.

Cause of the Decline of the Gold-mining.

The northern states of Sarawak appears, according to the export statistics, still to be of some importance with regard to gold-mining. Only quite recently the first gold mine has been started in Sabah, namely, on the R. Segamah.

In the following pages, therefore, I speak only of Dutch Borneo.

When we speak of the decline of the gold production of Borneo, we refer to the decline of the two territories which produce the greatest amount of gold, *i.e.*, the Chinese Districts, and Tanah-Laut; and here we only mean the production of the Chinese miners, as the natives and Europeans produce too little to be taken into account.

An exception must be made with those districts in the upper river-basins of the Kapuas, Katingan, and particularly the Kahajan,[1] which, according to Schwaner's accounts, are rich in gold: for gold in these districts has up to the present time only been worked by natives, and then only in limited quantities, this strip of land being almost as inaccessible for Europeans now, as it was forty years ago.

One cannot speak of a decrease in the southern districts of E. Borneo, since, so far, the gold has only been worked by natives, and the production has never been considerable, on account of the extortion which the gold-seekers have had to put up with on the part of their princes. Being deprived of their reward, they show no desire to dig further. Again, gold-seeking is the monopoly of the government. On this account we find no Chinese miners here.

The remaining districts are, however, so unknown, that it is impossible to say anything about them.

Of the gold districts, only Tanah-Laut and the Chinese district were under the direct rule of the Dutch, and here it was only where the labourers were protected, that gold mining could be freely developed.

The first step in the decline in W. Borneo, was caused by the war in the first half of this century, as mentioned in the historical part. This war lasted, off and on, for more than thirty years, ending in 1854, with the total submission of the former independent Chinese gold-seekers. Most of the capital had then been used up, many labourers had been killed, or had flown the country, and it was a long time before the Chinese again turned their attention to gold-mining.

In Tanah-Laut similar events appear to have taken place, with similar results. In this case it was a war carried on from 1859 to 1864, the result of which was the annihilation of the Sultanry. The gold and diamond mines, which had been for the greater part the property of the ruling families, now fell into decay; formerly they had been compulsorily worked by natives, but this now came to an end. The

[1] Maks also remarks the same of the latter river.

workers turned to other employments, and the mines were abandoned.

As a chief cause of this decline it is generally assumed that the richest and most accessible places have been exploited, and only the less productive ones still remain. Even in the twenties the same arguments were heard,—namely, that the mines in Mandhor and Mampawa were already for the most part exhausted, and in the forties these complaints were again repeated, and are, therefore, nothing new.[1] This is, for the most part, true, but it is highly probable that several deep rich valley deposits are still in existence, which have not yet been worked, principally for the want of technical knowledge, and more particularly for want of working capital to begin with.

We have seen that when the miners were at their best, there were three large unions in existence in W. Borneo, which by joint action could make the necessary advance of capital, the first condition necessary for a great undertaking, and that at present this money fails. On this account, only a few workers unite to exploit the more accessible grounds. Those more difficult of access, remain unopened up.

That such districts still exist, is proved by the statements of the mining-engineer Hooze, who directed the geological and mining investigations in Tanah-Laut. He says, namely, "We are still ignorant as to the extent of the valley deposits." A comparison with the similar conditions in Bangka is instructive. Here as in Borneo, the natives and Chinese had begun on their own account to work the tin and gold deposits.

On both islands, the hill-deposits were first exploited, as they were the more accessible, and could be worked without much trouble. This, in most cases, repaid the work richly. No one thought of working the deeper beds, more

[1] Veth W. 17, I. 327.

difficult of access, so long as rich hill-deposits (*Kulit* and *Kulit-Kollong*) were still to be found.

The exploitation of the hill-deposits marks the first period of the mining. In Borneo it has lasted to the present day. In Bangka it was brought to an end at the beginning of the fifties by the mining-engineers, who, armed with the necessary technical knowledge, which the Chinese had not, studied the valley-deposits by means of boring investigations. At the same time it was shown in Bangka that valleys which were supposed to possess no ore, were found to contain much tin, and those which were supposed to contain much ore, contained little tin. Supported by the mining-engineers, and financially by the Indian government, they were enabled to make a larger outlay, and commenced to work the productive valley-deposits (*Kollong*), and along with this the *Kulit* mines. This is the second period of the drift and alluvial mining, which in Borneo, has not yet begun.

But the hope still exists that more detailed investigations, and greater working capital, will lead to the working of the rich valley gold deposits, which are as yet untouched.

Thus there are in W. Borneo, in the basins of the rivers Lambas and Sebangkan, deep gold valley deposits, which have not yet been examined, and some are to be found in the Skadau mountains.[1]

With regard to boring investigations, the mining-engineer, Van Schelle, believes that they would not give such favourable results as in Bangka, as a very small difference in the percentage of gold would make the mine rich or poor, which is not the case in that island.[2]

Perhaps, the present low price of gold in Europe, as in Borneo, may be also looked upon as a cause of the decline.

It would then be the same case as it is with the diamonds (through importation of cheap Cape diamonds).

[1] Jb. 1884, II. 258. [2] Ib. 1880, II. 35.

Future of the Gold-mining.

Let us consider, in a few concluding words, the future of gold-mining in Dutch Borneo.

It has been already mentioned, that the production of the Chinese, as it is at present carried on, is not capable of development, but is continually going back, as the accessible districts become exhausted.

It could, however, be improved, as in Bangka, if the government, or European capital would lend help, either in a technical or financial form, by correct preliminary investigations of the richness of the ore of these districts (test borings), by improving the method of working, by the introduction of mechanical means of conveyance of the material to the washing canal, by the employment of dynamite in blasting, by preventing the loss of gold in the washings, and by financial assistance in the shape of easy advances, in order to encourage the working of the deep-lying valley deposits. Then it might even pay to work the poorer districts.

This would certainly be the most profitable solution of the difficulty, as Europeans command greater capital than the Chinese.

With regard to the exploitation of the veins, the investigations of Van Schelle have shown that the quantity of ore diminishes with the depth, and that they are not worth working.

DIAMONDS.

Historical.

The diamonds of Borneo were known and celebrated long ago, as they could well compete with those found in other parts of the world, both in regard to quality and quantity.

Diamonds form the chief, and most valuable product of this island, and in former times almost all the natives in the diamond districts were engaged in searching for diamonds.

The superior characters of this gem were at once noticeable to the natives, and allured them to further exploitations. The diamond-mines in Landak are, according to Raffles, as old as the Malay régime in Borneo; those of Sangow belong to a later period, and those lying in the district of Bandjermassin were first discovered under the government of the Sultan Sepu (end of the seventeenth century).[1] It was also the diamonds which attracted the Europeans to the west coast of Borneo. At this time, the Landak diamonds appear to have been better known. It is said that the name Landak hedgehog is an allusion to the digging and grubbing of the soil, which from the earliest time, had been the usual employment of the natives.

The principal diamond diggers were, however, the Chinese, who were employed by the native rulers, as they were far superior in skill to the natives, and gave the chiefs greater prospects of profit.

At the beginning of this century, the diamond digging was almost entirely in the hands of the Chinese. In course of time, however, they mostly left the work, on account of their small gains, and by reason of the impositions of the rulers; so that, in the beginning of the twenties, diamond digging had almost ceased in Landak.

The most flourishing period of the diamond digging and washing was under the old East India Company. At this time, many diamonds were exported; and, as Batavia was the only market to which they could be brought, it is said that, in few European courts was there such a luxury in diamonds as existed in Borneo at that time.

With the fall of the company, the trade in diamonds decreased. In 1823 the Indian government tried to raise it again. The prince of Landak leased his diamond mines to the government for a certain sum of money annually, and

[1] Veth W. 17, I. p. 70.

the government bound the workers to hand over all diamonds at a set price. Their object was, however, never attained, perhaps, because all the diamonds found were not given up to the government. On that account, four years later, in 1827, the contract with the native prince was dissolved, and the latter again resumed his rights over the mines. In 1831, a second attempt was made to give the diamond diggings a new impetus. The conditions were the same; but these attempts also proved fruitless, so that, in 1833, the monopoly of the diamond diggings was abolished; and it was open to anyone to dig for, and to sell the diamonds.[1]

At present only the natives busy themselves, in a desultory way, with diamond digging, while the Chinese have turned almost altogether to the more profitable search for gold.

Latterly, attempts have been made in Tanah-Laut to promote the diamond washings. A few years back, French engineers began a more regulated exploitation of the diamonds in Tjempaka (South Borneo).

OCCURRENCE.

The occurrence of diamonds is the same as that of gold. They are met with under the same geological conditions, and are found in Alluvial deposits, in the sand of rivers, and in Diluvial deposits. They have not yet been found *in situ*.

There is some difference, however, between the gold and diamond beds. Whereas the gold occurs in greater or less quantity in most of the rivers, and is also widely distributed in the *seifen*, the diamonds occur only in certain districts of no great extent.

ALLUVIAL.

Diamonds are only found in the alluvium of those rivers that flow through the diamond districts. They are associated with auriferous quartz sand.

---

[1] Veth. W. 17.

DILUVIAL.

Distribution.

With regard to the distribution of the diamond districts, it is to be remarked that they coincide with the richest gold districts. They are of especial frequent occurrence at the foot of the spurs of the south-east and north-west of the mountain-chain; thus in Tanah-Laut (south-east), on the western flank, and in Kusan, on the eastern foot of the same mountain-chain, and similarly in Landak and Sangau, on the south foot of the mountains forming the boundary between Sarawak and West Borneo, and in the basin of the Sarawak, in Sarawak proper.

Besides the above-mentioned districts, we have no proof of the existence of other diamond fields.

In South Borneo, diamond-fields exist in Tanah-Laut. In this district the Diluvium which contains the diamonds extends along the sea-side of the Tertiary sandstone hills.[1] Especially famous is the neighbourhood south of Martapura, where there is an undulating ground of some miles extent, in which most of the richest gold and diamond mines occur (near Udjong murong, Sungei Runtai, Sungei Pinang, Gunong Lawak, and Gunong Bassun). The two latter are in the possession of the former sultan.[2]

According to Von Gaffron's[3] report, there are also diamond-deposits in the west parts of South Borneo; thus in the district Katingan, at the foot of the mountains Merundau, and on the banks of the brook of the same name (basin of the Pembuan); further in the whole of the southern portion of the district of Kotaringin, and probably, also, in the basins of rivers Bulik and Delang (tributaries of the Samandan, belonging to the river Kotaringin).

---

[1] Javaverslag, 1883, IV. [2] Horner, S. 2, and De Groot, S. 23.
[3] V. Gaffron, S. 27.

In E. Borneo the state Kusan[1] is famous for its diamonds.

Diamond mines occur half a mile to the interior from Batu-Beruang (above the chief town Prabu-Harta; *e.g.*, near the brook Van-waan.) In the upper basins of the Kusan, and its tributaries, gold is found in the same beds with diamonds; and the richest mines in Borneo are stated to be in the last-named district. Further, diamonds also occur in the rivers Batu-Litjin and Bangkalan (Tanah-Bumbu).

In W. Borneo the district Landak is famed for its diamonds.

Most of the diamonds occur between Ngabong (Landak) and north of Djambu, on the R. Landak; the higher up-stream the bigger the diamond, so that diamonds which are considered to be big in Ngabong, are held to be small in Djambu. It is peculiar that while diamonds occur in the valleys of the rivers, very little gold is found. The latter is found in greater quantity in the tributaries (Belantian, Menjuki, Behe, Deid, Padei).[2] Diamonds also occur in the rivers Sungei Ampar, S. Ngabong, S. Monggo, S. Bantangkire, and Batang kanan.[3]

In the state Sanggau most of the diamonds occur in the upper Sikajam, and in the district of the R. Merau, and its tributaries towards the boundary with Sarawak,[4] further near Samarang-kai, and in the brook Ingis.[4]

Besides in this rich diamond district, diamonds are said to occur along the R. Kapuas, near Beang, Tapang, Tongko, Batu-Patah, and in the rivers Mapey,[5] Sayo, Kunjit, Kindor, Menkarong, Sinkawang,[6] in the neighbourhood of Biang, below Skadau;[7] further near Tanah-Patah, on the right bank of the Kapuas.[8]

---

[1] Smits, E. S., Nieuwkuy, K. E. 12, Weddik, E. 3, Horner, S. 2, Schwaner, E. 5.

[2] Schultz W. 38, p, 53.

[3] Peeters W. 32.

[4] Van Kessel W. 8, Van Lynden, W. 11.

[5] W. 9 and 7.

[6] Peeters W. 32.

[7] Everwyn W. 39, p. 17, 36, 38, 39, 99.

[8] Low N. 1.

Diamonds are also said to occur[1] in the state Sekadau, along the river Pinoh, and in the upper basin of the Melahui; also on the R. Djonkong.[2] But this has only been confirmed for Landak and Sangau.[3]

In N. Borneo, diamonds were, till quite recently, only known in Sarawak, and there only in the western part of the basin of the R. Sarawak, towards Sambas.[4] The river Sentah is especially mentioned. This river to the Penrissan branch of the R. Sarawak, and contains diamonds of a citron-yellow colour.[5]

In Sabah, two diamonds, one of which weighed one-and-a-half carat, have been recently found in the Quarmote (a tributary on the right bank of the R. Kinabatangan).[6]

Composition.

Like the gold, the diamonds occur in the hill and valley drifts, the latter being termed "Kulit" and "Kollong" mines, by the washers.[7]

We possess, however, little information with regard to the hill deposits, and they appear to be of rare occurrence.[8]

The following is restricted to the valley deposits :—Their composition resembles that of the auriferous drift, with which they are often associated. The hanging wall of the diamond beds consists, everywhere, of a clay, more or less coloured with oxide of iron, and sandy in places, its thickness being from a half to several metres. In Kusan the diamonds lie, for instance, at a depth of two to three fathoms;[9] at Bandjer-

---

[1] W. 9 and 7.

[2] Peeters W. 32.

[3] Everwyn W. 39, p. 17, 36, 38, 39, 99.

[4] Low N. I.

[5] Everett N. 23.

[6] *Handbook of Brit N. Borneo*, N. 49.

[7] Schultz W. 38.

[8] W. 33, p. 30. According to Van Schelle, they only occur in the Diluvium, not in the debris (Jb. v/h. M. 1884, I. 132).

[9] Weddik E. 3.

massin, on the other hand, at a depth of ten to twelve fathoms. Under this lies the diamond bed, which also varies in thickness.

In many places successive layers occur, varying from the finest sand to a pebbly gravel, as, for instance, in a diamond mine in the upper basin of the R. Sikajam, where the Diluvium, which has a thickness of twelve metres, consists of three layers, varying from the finest sand to a pebble bed.[1] This pebble bed consists of quartz; but, besides quartz there is also quartzite, quartz-schist, weathered shale, quartz sandstone, eruptive rocks, like diorite, syenite, gabbro, white kaolin-like fragments, which are probably the alteration products of rocks rich in felspar, further crystalline aggregates of hornblende, and ore.[2]

Accompanying the diamonds are small, somewhat rounded, bluish or bluish-gray crystals of corundum (Batu Timahan[3] or Tatimahan), they are corroded on the surface, presenting small holes, and cavities in which iron pyrites occurs in finely-sprinkled crystals, and, according to Horner, a leaden grey mineral which he takes to be platinum. Triangular depressions also occur (impressions of the faces of diamond crystals).[4] This corundum has not yet been found in the matrix.

Of rare occurrence in the diamond bed are fragments of coal (in the mine near the brook Ingis, above Sangau,[5] and near Gunong Lawak),[6] or species of still existing shells, such as ostrea, cardium.[7] In this bed the diamonds

---

[1] Van Schelle W. 62, p. 128.

[2] Everwyn W. 39.

[3] Was formerly thought, on all hands, to be quartz; Dr. Cretier (Jb. v/h. M. 1884, II. p. 317) first proved that it was corundum, having a specific gravity of 3·4 to 3·7, and hardness 9.

[4] Horner S. 2. Verbeek S. 41, p. 102.

[5] Van Lynden W. 11.

[6] C. de Groot, S. 23.

[7] Horner S. 2.

occur, sometimes accompanied by gold and magnetic iron ore.

The foot-wall consists of a very weathered rock, a product of decomposition of the country rock, having an undulating surface. The natives call it the "dead earth," and cease digging as soon as it is reached.

The diamonds are usually accompanied by gold.

According to the statements of the natives,[1] these two minerals occur in inverse proportion to one another, that is to say, in a mine where many diamonds occur, there is little gold, and *vice versa.*[2] But the French engineers in Tjempaka assured me during my stay in Borneo, that the reverse was the case. It has been already mentioned that in general the diamond districts coincide with the districts richest in gold; but the gold is uniformly distributed, while the diamonds occur only in few places.

The following section is given by C. de Groot in a diamond mine south of Martapura, near the brook Pring.[3]

Soil,	... ...	0·10	metres,	hanging wall.
Clay,	... ...	1·00	"	
Sand,	... ...	1·10	"	
Diamond bed,	...	0·5	"	
Sandstone,	...	3·40	"	ferruginous foot-wall.

In Landak, near the fork of the river of the same name, there was, in the beginning of the fifties, a small diamond mine with the following section:—

Sandy clay, 1·5 metres.

Diamond bed, 1·5 to 2·5 metres.

Clayey sandstone, foot-wall.

---

[1] The gold found in the diamond bed is called by the natives "mas intan" (diamond gold)—Schultz W. 38.

[2] Schwaner S. 17, I. p. 61.

[3] C. de Groot, S. 23.

In the diamond mine near Sekai (upper basin of the R. Sikkajam), the following beds have been recorded :—[1]

Red clay, 2·0 to 6·0 metres = Alluvium.

Clay, sand, and pebbles, 2·0 to 4·0 metres = Diluvium.

Age of the Diamond-deposits.

We have as little positive evidence for the age of the diamond-beds as we have for the age of the auriferous deposits. But as they both occur in the same bed, their age is in many cases the same, and doubtless a very recent one. Perhaps a part is of Alluvial age, as species of shells which are still in existence have been found in the diamond beds; another part may be older, but the difference in age, if it exists, is only small.

Van Schelle[2] states that the diamond-deposits are not all of the same age. He distinguishes between an older and a younger Alluvium; most of the diamonds occur in the former, in a pebbly gravel, consisting chiefly of fragments of quartz with quartz sand.

In the younger Diluvium which is only raised slightly above the highest level of the rivers, and often merges into the Alluvium, the pebbles consist chiefly of slate.

Diamonds occur but sparsely in this. Van Schelle also states that the auriferous deposits are often younger than the diamond-deposits, and that in the latter the pebbles are almost always deposited in layers.

Diamonds in the Original Place of Formation.

Up to the present the matrix of the diamonds in Borneo has not been discovered. Horner expressed the opinion that the Batu Timahan, that is the corundum, which is the faithful companion of the diamond, is the veinstone in which the

[1] Everwyn, W. 39, p. 53 and 134.

[2] Van Schelle, W. 62, p. 133.

diamonds occur, and based his opinion on the presence of triangular impressions on the corundum, which he ascribes to the face of the diamond crystals. But he found no diamonds *in situ*.[1]

Verbeek[2] believes that the diamonds are to be found in the old slate-formation, and Everwyn[3] subscribes to the same opinion. But according to the latter the only practical benefit to be derived from the parent rock is, that the direction taken by the products of decomposition might indicate probable diamond fields in the Diluvium.

It would not pay to work diamonds in the parent rock, as they are of such unfrequent occurrence.

It is worthy of remark that according to Professor H. C. Lewis,[4] the matrix of the diamond is serpentine =(weathered eruptive peridotite). He also states that in Borneo, diamonds and platinum only occurred in the rivers which traversed a certain district, and that the occurrence of chrome-iron and magnetic iron-ore in the same beds are in favour of this view. In how far this is correct is not yet known, but it should be remarked that Verbeek holds the original rock of the Bobaris mountains, which is a serpentine, for a dunite consisting of olivine, diallage, chrome-iron-ore, and magnetite.[5]

Diamonds in Eocene Beds.

On the R. Landak and the upper Sikajam conglomerate and sandstone beds occur, which (although no fossils have been found in them) probably belong, according to Van Schelle, to stage 4 of Verbeek's Eocene.

These conglomerates consist of fragments of flint, quartzite, and quartz sandstone, bound together by a siliceous cement; the sandstone which is greyish-green in colour, consists of quartz grains and mica scales, with an argilaceous and

---

[1] Horner S. 2. [2] Verbeek S. 41, p. 107. [3] Everwyn W. 39, p. 100.
[4] *Nature*, 1887, 13. [5] Verbeek, S. 41, p. 44.

siliceous matrix. Although diamonds have not been directly proved to exist in these rocks, this is very probably the case according to Van Schelle, since on the one hand, the greatest part of the diamond pebble bed consists of fragments of these rocks (river Sikajam), and, on the other hand, a Diluvial diamond district occurs in the neighbourhood of these beds.[1]

This would be a case analagous with the occurrence of gold in the Eocene pebble beds, of the sandstones containing fragments of the "old slates" in W. Sumatra (Bukit Kandung, and Pandjalangan).[2]

DIAMOND DIGGING.

By the Natives.

The natives obtain the diamonds by washing the river sand, and by sinking small shafts into the diamond beds.

The river sand is washed mainly after heavy rain, on the sandbanks of the rivers,[3] as is the case of the gold sand. A portion of the sand is placed in similar washing dishes (*dulang*), but which are much shallower than those used in gold-washing, and often measure a metre across.[4] By a shaking and rotatory motion, during which the dish is from time to time held under water, the sand is shifted, and the lighter stones removed by the current. The heavier sand remains in the dish in such a way, that the main portion is in the middle, the layer becoming thinner towards the edges. This thin layer is now examined for diamonds, and the remaining sand washed away.

This method is persisted in until all the sand has been washed.

A fine black sand collects in the middle of the dish during

---

[1] Van Schelle W. 62 p. 139.

[2] M. D. M. Verbeek, *Geologie van Sumatra's West-Kust* 1883, p. 559.

[3] In the eighties diamonds were still being washed in the sand of the rivers Merau and Sikajam (W. 62, p. 139).

[4] Van Schelle W. 62, p. 136.

the washing; this consists of magnetic iron-ore, gold, and platinum, and is called *Puja.*[1]

The washers are extraordinarily skilful in finding the diamonds, and do not let even the smallest ones escape them, while an unpractised man may examine the sand with a magnifying glass, and yet not succeed in finding any.

There is no tax on diamond-washing in river sand.[2]

In some districts superstition plays a great roll among the Dyaks (natives). Certain people are said to exist, who have the power of determining the place where diamonds lie buried, by an occult perception of their lustre, and even of determining the depth of the bed in which they lie. If they do not succeed in finding the supposed precious stones, in spite of the statements of the magicians, they comfort themselves with the idea that the stones have been secretly removed by evil spirits.[3]

According to Dr. Schwaner's[4] description, in the forties, these deposits are worked as follows:—

The natives first bore into the ground with an iron rod, until they reach flint pebbles, which produce a peculiar grating noise, and thus indicate that the diamond-bearing pebble bed has been reached.[5]

In Landak (W. Borneo), the flint pebbles are called *lebus,*

---

[1] Schwaner S. 17, I. p. 65.

[2] Verbeek S. 41, p. 101.

[3] Veth W. 17.

[4] Schwaner S. 17, I. p. 62 to 66.

[5] As already mentioned, the corundum plays an important practical part, for it is said to be the faithful adherent of the diamond. The diamond diggers declare, without exception, that where this mineral occurs, diamonds are sure to be found abundantly.

The relation between the corundum and diamonds is, in the opinion of the natives, perfectly natural; for the diamond is regarded as the prince of diamonds, and the blue corundum as its companion, the one never being present without the other.

According to a legend the diamonds are the petrified tears of an unfortunate princess (*ratu intan,* Diamond-queen) who loved and was betrayed, and scattered her tears in the wilderness.

and the diamond-bed, *areng*. The pebble-bed being reached, the real working begins.[1] First, small shafts of three to four feet diameter are dug down to the diamond-bed.

After the opening has been protected from an influx of water by an erection of dams, the shaft is surrounded by a wooden frame, thin stakes are then driven in down to the bottom of the shaft, and the space between these and the walls of the shaft is filled with dried grass in order to prevent the earth from falling in. If the shaft is deep, the wooden frames are repeated, and these serve again as supports to the vertical stakes.

Small levels are now driven in all directions into the diamond-bed. If the level is a long one, it is also prevented from falling in by a wooden framework, which is connected with the roof by means of long poles.

Small shafts, which have been dug in close proximity, are often brought into communication by means of these levels.

Small ladders are fixed along the walls of the shaft, on which miners are stationed, either to raise the diamond earth in baskets, which go from hand-to-hand, or to carry out in buckets the water which accumulates at the bottom.

This very primitive method of raising water, causes a great expenditure of time and trouble, for during the night the mine generally gets full of water, and the work has to be begun the next morning by bailing it out.

The diamond sand thus raised is sifted to remove stones bigger than a bullet, and is then heaped up in the neighbourhood of the mine, until a sufficient quantity is accumulated; then the washing begins, either in a neighbouring brook, or in an artificial canal.

The diamond sand is washed in a sieve (*angkatan*). The sieve consists of a basket one foot and a-half long, and three-quarters wide. It is made of bamboo, and in such a way,

---

[1] Schultz W. 38.

that it will let the water through but not the sand. The sand is removed from associated mud, by dipping it under water, and stirring it with the hand in the washing sieve (*ajak*), which also consists of a bamboo basket four feet in length, and one and a-half, in width.

The cleansed sand is then placed in second washing-sieve having larger meshes, to the under part of which is fastened a holder, while the upper sieve retains the larger grains, which are looked over for diamonds, and then thrown aside. The fine sand is again washed in the washing-dish, in the manner already described. The whole process consists in the removal of the mud, separating the coarser from the finer sand, and washing the separate products.

The washers, of whom each has his particular work, are subject to the inspection of three overseers: one controls the washing of the coarse sand, the second, the washing of the fine sand, while the third controls both.

This is necessary, because it sometimes happens that a washer, in an unobserved moment, will quickly swallow a diamond, and thus securely hide it.

At the time of the Sultan's rule, a man suspected of diamond-stealing was subjected to the following process:—an aperient was administered, and the evacuations were examined for diamonds. If any were discovered, the man was severely punished. In more recent times, this process has fallen into disuse, but no other means have been found of recovering lost diamonds.

The diamonds found in washing are placed in a small copper box, the bottom of which is covered with gum, in order to prevent the diamonds being lost should the box be knocked over.

Diamond Digging by the Chinese.

The river sand is seldom washed by the Chinese, and then only by the women and children. The operation is similar to that already described.

The diamond-beds are worked in the same way as the auriferous-deposits already described, the washing process being somewhat modified on account of the smaller specific gravity of the diamonds.

The washing canal, which is constructed of wooden boards securely fastened together, as in gold-washing. The stream is considerably smaller than in the latter, in order to prevent the small diamonds being also washed away.[1] As soon as sufficient material has accumulated, the current of water is still further diminished, and the large stones removed with a shovel, the residual sand being then washed in the washing-dishes in the manner already described.[2]

During the process diamonds are carried away by. the water current, and in order to recover them, the sand is washed by the women and children, as in the case of gold.

It is estimated that the cost of diamond-washing is covered by the small diamonds found, the larger ones being then regarded as profit.[3]

As in the gold-digging, the method practised by the natives is very primitive, while that in use by the Chinese stands on a higher stage of development.

In spite of this, many drawbacks exist, as already indicated, in treating of gold.

Diamond-digging by Europeans.

The French engineers in Tjempaka make use (since the eighties) of a steam-engine in working the diamond bed. But the washing is carried on in the usual Malay manner, which

---

[1] Schultz W. 38. In Landak there is said to be a depression at the end of each part, in which the diamond-formed sand collects.

[2] Van Schelle W. 62, p. 135.

[3] Schultz W. 38.

has the great drawback that many diamonds are liable to be stolen.

In Sarawak, where only the Malays work the diamond bed, a European tried his hand at diamond-washing in the seventies, on the R. Sentah, but soon abandoned the project as profitless.[1]

Variety and Form of the Diamonds.

The external appearance of the rough diamonds, especially of the large ones, is similar to that of transparent quartz-grains, with a somewhat dull and striped surface; while the small striped ones are more lustrous, and more nearly resemble the cut stones. They all present crystal forms, but with rounded edges and corners as if they had been rolled. This is especially the case with the small diamond, in which there is often no crystal form perceptible, and which have the appearance of small pebbles.[2]

Usually the form is the octahedron alone[3] or in combination with the cube and the rhombic dodecahedron. There are often present the hexakis-octahedron, the triaxis-octahedron, and hetrakis-hexahedron; seldom the rhombic-dodecahedron alone.

Tetrahedral twins often have a tabular form, due to some of the faces being unduly developed.

Fragments of diamonds also occur, flat pieces of which one face is a cleavage face.

If a diamond still has its sharp edges and corners, the natives call it *intan mendjadi, i.e.*, ready-made diamonds, that do not require cutting.

The uncut diamonds they call *podi*, and the cut ones the *intan*.[4]

---

[1] Everett N. 23, p. 28.
[2] Verbeek S. 41, p. 102.
[3] Van Schelle W. 62, p. 136.
[4] Schultz W. 38.

The different varieties are the following :—[1]

Intan hitam (black diamond),—bottle-green, has great value.

Buntat intan—is heavy, hard, and not suitable for cutting. Some are quite round, like hailstones, and are used as talismans.

Intan medjadi[2] (perfect diamonds),—do not require to be cut.

Intan ajer-Laut (diamonds of the colour of sea-water),—bluish, clear, and rare.

Radja intan (king of diamonds),—red diamond, very rare.

Intan minjak (oil-diamond),—brown.

Chaping,—triangular flat form.

Most of the diamonds are water-clear or yellow.

Price of the Diamonds.

Of the different varieties, the black diamonds are of least value, the yellow ones are cheaper than the water-clear ones, the blue ones are dear and much sought after.[3]

In general, the price depends on the form, colour, and purity, The small stones, below thirty-one carat, are relatively dear, as they are used by the natives themselves for decorative purposes, while the bigger stones are cheaper.[4]

The price also depends on the demand. In the rainy season it is, in general, low, since few diamond dealers visit the mining districts in these months.[5]

In the forties, the price of diamonds was calculated in Bandjermassin, by multiplying the square of the carat number by twenty for the uncut stones, by thirty for the cut ones.[6]

In the fifties (1858), Peeters gives the following prices for the stones from Landak :[7]

One carat, 40 florins.

---

[1] Smits E. 8.
[2] Schultz W. 38.
[3] Verbeek S. 41, p. 102.
[4] Peeters W. 32.
[5] Schultz W. 38.
[6] Schwaner S. 17, p. 68.
[7] Peeters W. 32.

Two carats, 40+40 florins =80+20 per cent. =(16)= 96 florins.

Three carats, 40+96 florins =136+20 per cent. (=27·50) = 163·20 florins.

In 1870, Verbeek[1] gave the following calculation for uncut stones in S. Borneo (Martapura) :—

8	Stones of	$\frac{1}{8}$ Carat,	...	...	30	florins.
4	„	$\frac{1}{4}$ „	...	...	40—42	„
2	„	$\frac{1}{2}$ „	...	...	46—48	„
1	„	1 „	...	...	60	„
1	„	2 „	...	...	160	„
1	„	3 „	...	...	300	„
1	„	4 „	...	...	480	„
1	„	5 „	...	...	700	„

The price of stones of more than one carat does not rise according to the square of the weight, but as follows :—

For the 1st carat,	60	...	florins.
„ 2nd „	2	(60+20)	„
„ 3rd „	3	(60+20+20)	„
„ 4th „	4	(60+20+20+20)	„

For the 5th carat, $n \times (x+(n-1)\ 20)$, $\therefore\ x=60$ per cent.

This formula, however, applies only to stones of one to five carat; for larger stones the formula gives too high a price. Thus, a stone of ten carat would cost 2,400 florins by this formula, whereas its price is only about 2,000 florins.

For the seventies (1877), Schultz[2] gives the price for uncut stones as follows :—

Diamonds from	$\frac{1}{4}$ Carat,	...	...	4	dollars.
„	$\frac{1}{2}$ „	...	...	9	„
„	1 „	...	...	22	„
„	$1\frac{1}{2}$ „	...	...	35	„
„	2 „	...	...	60	„
„	3 „	...	...	110	„
„	4 „	...	...	180	„

[1] Verbeek S. 41, p. 102. [2] Schultz W. 38.

The Belahans (see diamond cutting) are cheaper :—1 carat =20 dollars, 1½ carat=30—32 dollars.

Van Schelle[1] gives for the eighties in West Borneo the the following prices, according to different formulæ :—

Number.	Weight in Carats.	Price according to old Indian rule.	Price according to Verbeek.	Price asked at the Mines.	Price in Pontianak.
		florins.	florins.	florins.	florins.
1	0·346	--	--	11·50	15·50
2	0·44	--	--	11·50	15·50
3	0·766	--	--	35·00	47·00
4	1·634	160	118	92·00	125·00
5	4·5	1,215	585	253·00	345·00
6	5·0	1,500	700	345·00	469·00
7	8·75	4,590	1,880	1,150·00	1,564·00

According to this calculation, the old Indian rule gives prices much too high, as is also the case with Verbeek's calculation in dealing with the bigger stones.

Van Schelle gives no new rule; a long stay in the diamond district is necessary to enable one to do that.

Diamond-Cutting.

The art of diamond-cutting has been known to the natives for many years. Sultan Sapoh brought diamond-cutters from Java, Chinese merchants having drawn his attention to the greater value of cut stones.[2]

In Landak the distinction is made between Brilliants and Belahans. The latter are flat stones, which are cut in two and polished separately.[3]

The octahedral form are cut as brilliants; the *intan mendjadi* are not cut at all; while the rounded stones and chapings are cut as rosettes.[3] Usually the cutting is done in Europe.[4]

---

[1] Van Schelle W. 62 p. 137.

[2] Schwaner S. 17, I. p. 68.

[3] Van Schelle W. 62, p. 136.

[4] Verbeek S. 41, p 103.

There are numerous places for diamond-cutting; but their number has considerably diminished in recent years, with the decline of the diamond trade. Thus, in 1838, there were sixteen places for diamond-cutting in Ngabong, the chief town of the diamond district Landak; while twenty years later (1858) the number had sunk to seven.[1]

A large amount of the work is done in Pontianak, also in Martapura, where, in the beginning of the eighties, I had the opportunity of visiting the diamond-cutting establishment.

The Largest Diamonds found in Borneo.

For a long time the "Danan radja" was considered to be the largest diamond found in W. Borneo. It was in possession of the Sultan of Matan, and was said to be as large as a pigeon's egg, and to weigh 367 carats.

There are many legends connected with this diamond, and much has been written about it.[2] But there was always a suspicion current that it was not a genuine stone. In order to settle the point it was submitted to examination in 1868, when it turned out to be rock-crystal (as already suspected by Von Gaffron),[3] it being easily scratched by corundum, and having a specific gravity of 2·63.[4]

The second largest diamond—the "Segima," is said to be in the possession of the Sultan of Matan, and to weigh seventy carat.[5]

The largest diamond found in S. Borneo before the fifties, weighed seventy-seven carat, and was found near Gunong Lawak. It ultimately came into the possession of the Sultan of Martapura.[6]

---

[1] Peeters W. 32.

[2] Veth W. 17.

[3] Von Gaffron, W. 16.

[4] The "Brooke diamond" from Sarawak also proved to be a Topaz (Everett N. 23, p. 16).

[5] Everwyn W. 35.

[5] S. Müller 22, and S. 5.

In 1865 a stone of twenty-five carat was found in Tjempaka (S. Borneo). In cutting it was reduced to eighteen and a-half carat, and was worth 15,000 florins.[1]

A stone, weighing eighty carat, is stated to have been found, near the end of the eighties, in the district Landak. It was stolen, and sold in Sarawak for 30,000 florins. Even if its weight is somewhat exaggerated, it seems, according to common report, to have been a very large stone.[2]

A stone of seventy carat was also found in Landak in the fifties or the sixties. It is of the purest water, and is, at present, in London, under the name of the "star of Sarawak."[3]

Up to the fifties, the largest diamond found in Landak was stated to be a stone of 26⅝ carat, in possession of the prince of Landak.

In 1825, the following stones were found in Landak:—

A stone of 23⅛ carat, value 12,000 florins.[4]

„ 18⅝ „ 4,000 „

Another stone, 54 carat, was presented, in 1686, by the prince of Landak to the king of Bantam.

According to Raffles, the then prince of Landak possessed stones of eighteen and fourteen and a-half carat; and Ritter, during his three years residence in Landak, saw a stone of forty-two carat (stated to be too hard for cutting), and a second weighing 22¾ carat.[5]

Schultz also mentions two uncut stones of forty carat. They are stated to be of irregular form, and are in the possession of the Panembahan of Landak. The prince of Sanggau is also said to have two bottles full of diamonds.[6]

---

[1] Verheek S. 41, p. 105.

[2] Van Schelle W. 62, p. 139. Probably the same stone, as mentioned by Everett, from the basin of the Upper Sikajam (1875), and weighing 76½ carat.

[3] J. Hatton, N. 35, p. 51

[4] Peeters W. 32.

[5] Veth W. 17.

[6] Schultz W. 38.

Larger diamonds appear to have been found in former times, than in recent years.

It is stated that, during the thirties, stones of from four to ten carat were found almost daily in the mines near Martapura, and the same story is related of the diamond fields in Landak.[1]

In the seventies and eighties, stones of more than four to five carat had become very rare.[2]

DIAMOND OUT-PUT.

We possess as few details with regard to the out-put in diamonds as we do in respect to gold.

The causes are the same, namely, the custom of keeping no account of the true yield, and the secrecy maintained with regard to profits.

Only so much is certain, that the out-put in diamonds, like that in gold, was considerable in the preceding century; that it has diminished in the course of time, and, at the present moment, is reduced to a minimum.

Besides the report of the natives and of the traders, we have an eloquent proof of this in the extent and number of the mines formerly in existence.

In Tanah-Laut, in S. Borneo, there were, in the thirties, some hundreds of mines, and several thousand workers; near Gunong Lawak alone (1836), 200 mines and 3,000 to 4,000 miners.[3]

In the state Kusan, in E. Borneo, there were, in 1848, five mines, with about 200 miners.[4]

In 1853, 1,500 small diamonds were found in six months; in one mine often more than 600 florins have been earned.[5]

In the eighties, diamonds were not much sought for, as the more accessible places had been exhausted, and the remaining ones required much trouble and labour.[6]

---

[1] Müller S. 22 and S. 5.
[2] Van Schelle W. 62, p. 139.
[3] Horner S. 2.
[4] Weddik E. 3.
[5] Smits E. 8.
[6] Nieuwkuyk E. 12.

In W. Borneo, in the district Landak, there were :—

In 1822, 10	diamond	mines, with	170	miners	(Chinese).[1]
1823, 37	„	„	124	„	„
1857,	(?)	„	109	„	„
1858, 57	„	„	87	„	„

The number of miners in Landak (gold and diamonds) diminished between 1876 and 1880 from 600 to 250.[2] In the gold and diamond[3] mines were :—

In 1881,	...	...	344 miners.
1882,	...	...	351 „
1883,	...	...	367 „
1884,	...	...	87 „

In the state Sanggau, on the other hand, there were :—

In 1857,	...	...	462 miners.
1858,	...	...	300 „

The decrease in diamond-cutting also indicates the gradual decline of the production and of the trade.

In Ngabong, the residence of the prince of Landak, there were, for instance, in 1838, sixteen diamond-cutting places, but during the succeeding twenty years their number sank to six.

The few data we possess with regard to the diamond trade are the following :—

In 1738, according to Raffles,[6] diamonds of the value of

[1] Bydrago W. 5.
[2] Jh. v/h. M. 1884, II. p. 288. Ib. 1885, II. p. 329.
[3] Ib. 1886, II. p. 127.
[4] Peeters W. 32.
[5] According to Raffles, in the beginning of this century, the average annual yield obtained by eight Chinese was eight bungkal of diamonds, having a value of 20 to 24 gulders (Veth W. 17, I. p. 18).
[6] Veth W. 17, p. I. 70.

eight to twelve million gulden (=200,000 to 300,000 Spanish "matten") were exported.[1]

In the beginning of this century the exportation amounted to about a million.

For the years 1836 to 1848 we possess a few data, taken from the trading reports, with regard to the value of the diamonds imported into Java and Madura from Borneo.[2]

In 1836,	5,473	carats,	worth	110,601 florins.
1837,	5,245	„	„	97,140 „
1838,	5,947	„	„	117,550 „
1839,	3,484	„	„	92,552 „
1840,	1,891	„	„	62,410 „
1841,	2,122	„	„	56,520 „
1842,	3,980	„	„	80,875 „
1843,	1,315	„	„	33,900 „
1844,	unknown	„	„	46,450 „
1845,	„	„	„	60,825 „
1846,	„	„	„	128,450 „
1847,	„	„	„	96,210 „
1848,	„	„	„	67,200 „

The export trade from Bandjermassin (S. Borneo) was estimated by Horner at 17,000 to 18,000 florins; and Schwaner calculated the total yield in the state of Bandjermassin, in the forties, to be 240,000 florins.[3]

In Kusan, in the twenties, when the first diamonds were found, the yearly gain was 50,000 florins,[4] and in the forties, 40,000 according to Schwaner.

We have more exact details with regard to the years 1823 to 1927 in Landak, during which time the Indian government took the mines into its own hands.[5]

[1] A Spanish matten = ½ thail = 27 florins.
[2] Veth W. 17, I. p. 75.
[3] Horner S. 2; Schwaner S. 17.
[4] Smit E. 8.
[5] Peeters W. 32.

The following table gives the productions for five years:—

Year.	Number of Cut Diamonds.	Weight in Carats.	Price after deducting 20 per cent. for the Government.
			florins.
1823 ..	1,995	$356\frac{1}{2}$	4,302·54
1824 ..	8,451	$1,914\frac{7}{16}$	28,616·80
1825 ..	9,992	$1,878\frac{1}{4}$	37,517·90
1826 ..	6,075	$1,175\frac{5}{6}$	13,767·36
1827 ..	422	95	768·40
Total, ..	26,875	$5,420\frac{11}{32}$	87,207·92

The diamonds were sold for 113,134·15 florins; consequently the gain amounted to 25,826·23 florins.

According to official reports the export trade from Landak (Ngabong) was as follows:—[1]

In 1876, ...	4,062 Carat.
1877, ...	5,271 "
1878, ...	6,359 "
1879, ...	6,673 "
1880, ...	3,012 "
1881, ...	2,918 "
1882, ...	3,299 "
1883, ...	2,225 "
1884, ...	2,727 "

The trade in W. Borneo is chiefly in the hands of the Bandjarese, who purchase the diamonds from the washers. From Pontianak they are exported to Java, but chiefly to Singapore.[2]

In N. Borneo (Sarawak), the production appears never to have been great.[3]

In 1849 four localities were being exploited, but the out-

[1] Jb. v/h M. 1884, II. p. 288, and 1885, II. 127

[2] Shultz W. 38.

[3] Low N. I.

put was not large. We have official details with regard to the export since 1865, but the real export is much greater.[1]

The export is known for the following years, viz.:—

In 1865,	...	...	...	1,960	pounds.
1866,	...	...	...	300	„
1867,	...	...	...	500	„
1868,	...	...	...	355	„
1869,	...	...	...	1,360	„
1870,	...	...	...	662	„
1871,	...	...	...	1,050	„
1872,	...	...	...	—	

The causes of the decay of the diamond trade are various; but in general they are the same as in the case of gold.

In the first place, the more easily accessible ground has already been worked, and there is not sufficient capital available for working the lower-lying valley-deposits. There is no doubt that rich valley-deposits still exist, but without trial-borings, and the expenditure of larger sums of money, they must remain untouched.[2]

A further cause is to be found in the fact that the workers, natives and Chinese, are oppressed by the native princes, and mulcted of the greater part of their gain, and consequently prefer to abandon the work altogether. In many states diamond-digging exists as a monopoly, or most of the mines are in the possession of the ruling families. The natives are consequently obliged to work in the mines for a small wage, and to hand over all the large stones to the proprietors.

In Tanah-Laut (S. Borneo), where, in former years, every member of a princely family had his own mines, every diamond above two carats, had to be sold to the proprietor at the rate of twenty florins per carat. For each stone under

[1] According to A. H. Everett's communications, and N. 23.

[2] Van Schelle found, by means of a small boring tool, a diamond bed under the level of the river Sikajam (Jb. v/h. M. 1884, I. p. 148).

two carats, however, the worker received half the price; and the gold associated with the diamonds (*mas intan* =diamond gold) belonged to him.[1]

In Kusan (E. Borneo), diamond-digging was, and still is, a monopoly. All the stones bigger than three carats have to be given up to the prince at the rate of twenty florins per carat, besides the sum of one florin per month for the right of digging.[2] But the prince did not allow the mines lying farther inland to be worked on account of the insufficient control over them.

Since the eighties twenty-five florins are received by the finder for every diamond above two carat.[3]

In Landak (W. Borneo), all stones above three carat must be given up to the proprietors of the mines, and those above five carats to the prince for a small price.[4]

Before the eighties, the natives dug diamonds in the mines for the Sultan, receiving in exchange rice, tobacco, and one dollar per carat.[5]

In Sangau also the diamond mines were worked by means of forced labour, the slaves of the Sultan being during the twenties put to work there.[6]

A further evil is the insufficiency of the control exercised, enabling the workers often to secrete the diamonds.

One of the chief causes of the decline is the importation of Cape diamonds into Borneo. These are much cheaper, and, therefore, more sought after than the Borneo diamonds. But the latter wear better.

Thus it came that forced labour was no longer employed, especially in S. Borneo, where the royal mines had been abandoned. The diamond-washers also finding their work no

---

[1] Horner S. 2.
[2] Gallois E. 9 ; Weddik E. 3 ; Smits E. 8 ; Nieuwkuyk E. 12.
[3] The other diamonds are as big as a grain of rice.
[4] Peeters W. 32.
[5] Schultz W. 38.
[6] Bydrage W. 3.

longer so remunerative, preferred to adopt some other and more profitable branch of industry—*e.g.*, collecting forest products,—Spanish cane, wax, gutta-percha, digging for coal, etc.

With regard to the future of the diamond-mining it is the same as with the gold. A rich yield could doubtless still be obtained under proper technical supervision, and by using rational methods for finding suitable sites, and for determining the workability of the deeper lying valley deposits which are doubtless present in great numbers. A larger capital is also required, and better methods for mining, so as to be independent of the rainy season. But such a result can only be obtained under European control, and with European capital.

The "Borneo Mining Company," founded in 1884, ought to cause a revival; and other companies have been announced, and have applied for ground.[1]

It is also satisfactory that the government is now also endeavouring to restore the diamond-digging to a flourishing condition, by reducing the license for diamond-digging to one florin per month.

PLATINUM.

Platinum was discovered in Borneo in 1831 by Hartmann, then Resident in Bandjermassin (S. Borneo), and its occurrence was confirmed in 1836 by the naturalist Horner. It was found in the auriferous deposits in the form of scales or smooth granules, and discarded as worthless by the gold-washers, who called it *mas kodok* = "frog-gold."

The occurrence of platinum in Borneo is only known for certain in Tanah-Laut, the most south-easterly point of the island. Here it occurs in the gold and diamond mines along the Meratus mountains,[2] *e.g.*, near Martapura, Gunong-Lawak, Pleihari.

[1] Jb. v/h M. 1885, II. p. 331.

[2] Jb. v/h M. 1887, II., 163.

According to Von Gaffron, platinum-sand occurs in the auriferous deposits at some places in the basin of the rivers Katingan, and in the rivers Kumei, Biru, Sambi (tributaries of the river Kottaringin). But we have no later information on this point.[1]

In W. Borneo there is an old story to the effect that platinum-sand formerly occurred in great abundance in the auriferous deposits near Budok, in the Chinese districts; and in Sambas even formed an article of trade. But the Indian mining-engineers looked in vain[2] for it in the fifties, and Van Schelle in his later investigations also failed to find this noble metal.

The Chinese miners also know nothing of its occurrence.[3]

Up to the present platinum is not known in north or east Borneo.

The parent rock of the platinum is not yet known in Borneo. Horner[4] supposes a leaden-grey metal which occurs on the corundum accompanying the diamonds in the drift deposits to be platinum: according to this the platinum would be connected in origin with the corundum. Schwaner expresses no opinion on this point.[5]

Verbeek considers it probable that the platinum is derived from a serpentine rich in chrome-iron-ore as in the Ural mountains; but he did not succeed in proving this positively.[6]

The amount of the platinum in the auriferous deposits is very variable. In the year 1847 there were twenty-two gold-washing stations in the neighbourhood of Pleihari and Gunong-Lawak; of these only three contained platinum-

---

1 Von Gaffron S. 27.
2 Everwyn W. 39, p. 10.
3 Van Schelle Jb. v/h M. 1884, II. 291, and 1886, II. 129.
4 Horner S. 2.
5 Schwaner S. 16, p. 69.
6 Verbeek S. 41, p. 107.

sand, in the proportion of 1·10. In Ketapan the proportion was 1·5, and in Sungei Matjan, 1·20.[1]

It is known that Laurite (consisting of ruthenium, sulphur, and osmium), was first discovered in the platinum-sand of Borneo.[2]

ANALYSES.

The samples of platinum-sand sent by Horner to Batavia at the end of the forties, contained:—

Platinum	...	...	68·5 to 73·0
Gold ...	...	...	— —

Analyses made in 1847, gave the following result:—

Platinum	...	...	57·13 to 72·06
Gold ...	...	...	9·75 to 0·53[3]

Maier[4] found in the purified sand from Martapura:—

Osmium,	...	...	not determined.
Lead, Gold, and Mercury		...	„
Rhodium,	...	...	0·85
Iridium,	...	...	11·41
Palladium	...	...	0·20
Platinum,	...	...	72·63
Iron,	...	...	5·71
Copper,	...	...	0·62
Iridium-osmium,	...	...	6·92
Quartz, spinel,	...	...	0·30
			96·64

The platinum-sand was mixed with quartz, spinel, zircon, chrome-iron-ore, magnetite, and platinum-iron.

[1] S. Poggendorf's Annalen Band 103, and Bleekrode S. 25.
[2] Berenelot Moens B. 27.
[3] Bleekrode S. 25.
[4] Maier S. 33.

The ore itself, consisting of small scales with a grey silvery lustre, and having a specific gravity of 16·68, is very pure, the percentage of gold being small, and occurring combined with mercury as amalgam.

Böcking[1] obtained the following results from a sample of carefully-selected platinum grains[2] (among which was a good crystal presenting faces of octahedron and cube) which were mixed with grains of osmium-iridium, gold, chrome-iron-ore, magnetite, and a hard colourless ruby-red mineral.

Platinum, ...	82·60	
Iridium, ...	0·66	
Osmium, ...	0·30	
Gold, ...	0·20	
Iron, ...	10·67	
Copper, ...	0·13	
Iridium-osmium, ...	3·80	(insoluble in aqua regia.)
	98·36	

The other platinum-metals which were, perhaps, present, could not be determined on account of the small amount of material (two grms.)

Bleekrode's[3] analyses of the platinum-sand of Gunong-Lawak showed what an indefinite mixture platinum-ore is.

The analyses were carried out on the rough material (two grms.) just as it came to hand.

The ore consisted of irregular round scales resembling metal balls flattened out with the hammer, mixed with topaz, zircon, ruby, diamond, quartz, felspar, iron-sand. The ore was non-magnetic.

[1] Böck S. 18. [2] From what derived is not given.
[3] Bleekrode S. 26.

The analyses (carried out in 1857) are the following:—[1]

	1.		2.	3.	4.
Fe_2O_3 ...	1·13	soluble in HCl			
Cu O. ...	0·50				
Osmium,...	1·15				
Au. ...	3·97		4·62	0·90	1·33
Pt. ...	70·21		65·22	71·21	75·03
Ir. ...	6·13		1·53	9·23	3·22
Pall ...	1·44				
Rhod. ...	0·50				
Fe. ...	5·80				
Cu. ...	0·34				
Os. Ir. etc.	8·83	(insoluble in aqua regia),	9·61	8·13	10·15
	100·00				

According to Fritsche's analysis, platinum-ore from Tjempaka contained:—

Platinum, ...	72·69
Iridium-Rhodium, ...	15·9
Palladium, ...	4·09
Iron, ...	5 45
Copper, ...	0·48
	98·69

The ore consisted of grey, lustrous, flat granules, completely soluble in *aqua regia.*

By comparison with all the analysis available we find:—

	1.	2.	3.	4.	5. (Maier)
Pt.	68·5	73·0	57·13	72·06	72·63
Au.	—	—	9·73	0·53	not estimated.
Fe.	?	?	?	?	5·71
Cu.	?	?	?	?	0·62
Os. Ir.	?	?	?	?	6·92
Residue,	?	?	?	?	12·46

[1] The scales of platinum were covered by oxide of iron, and were, therefore, treated with hydrochloric acid. Verbeek S. 41, p. 107.

	6. (Böcking).	7. (Bleekrode).	8. (Fritsche).
Pt.	82·60	70·21	72·69
Au.	0·20	3·97	—
Fe.	10·67	6·62	5·45
Au.	0·13	0·72	0·48
Os. Ir.	3·80	8·83	—
Residue,	0·96	9·22	20·07

The amount of platinum varies from

			57·13 to 82·60 per cent.	
„	gold,	„	0·— to 9·73	„
„	iron,	„	5·45 to 10·67	„
„	copper,	„	0·13 to 0·73	„
„	residue,	„	4·76 to 20·07	„

The out-put in platinum is small. It has been mentioned that the natives were ignorant of its value; and only in recent years it is obtained as a bye-product in the process of gold-washing.

Horner[1] calculated in the thirties the annual yield in platinum as 10,000 ounce = 300 kilogrammes, and this he valued at 250,000 france = £650.[2]

But this calculation is not correct, because it is based on the assumption that the proportion of the platinum to gold in the drift-deposits, is always the same as in Pleihari, *i.e.*, 1 to 10. But, as already mentioned, this is not the case, and the greater number of washings contain no platinum at all.[3]

ANTIMONY.

The occurrence of antimony-ores is known both in South and West Borneo, as well as on the east and north coast. In workable quantity it has, up to the present, been found only in the state Sarawak, in the north of the island.

---

[1] Horner S. 2.

[2] Bleekrode S. 25.

[3] Dana says in his Text-book of Mineralogy, (1868, p. 11), that Borneo has a yearly produce of 600 to 700 lbs. platinum. Most probably he derives this incorrect statement from Horner.

Occurrence.

South Borneo.

Antimony is reported, by the natives, to occur in the upper course of the Limu, a tributary on the right bank of the Barito, and also in the river Rungan, a tributary on the left bank of the Kahajan.[1]

Antimonite was first found in the basin of the Kapuas, on the banks of the tributary Hiang, by Controller Arnout.[2]

According to Von Gaffron,[3] antimony-ores occur in several places in the western parts of South Borneo. He received samples of this ore from the mountains forming the divide between the rivers Kapuas and Katingan. It probably also occurs in the mountains Russa and Bassa, in the mountains forming the divide between the basins of the Katingan and the Pembuang, and near the sources of the river Sunan in the district Pembuang.

No details are known.

West Borneo.

Already, at the end of the forties, and the beginning of the fifties, reports were in circulation that antimony-ore had been found in several places in W. Borneo; *e.g.*, on the river Kelah (Ella) a tributary of the Melawi, on the river Merenkiang (a

---

[1] Such reports emanate, in all cases, from the natives. But everyone who has had to do with natives know that they are not altogether reliable. Then, also their knowledge of rocks and minerals is small, so that similar stones are often confounded: specular iron, with galena or antimonite; iron-pyrites with gold, white mica with silver, red jaspar or carnelian, with cinnabar, carbonaceous shales with coal—mistakes which can be easily pardoned as they are also made by Europeans, The native name for antimony-ores is "*Batu perak*" (=silver stone) or "Batu Sarawak" (=Sarawak stone), because it is abundant in Sarawak. Antimony is used by the Chinese as a drug, and is imported from Singapore and Sarawak. (See Jb. v/h. M. 1879, I. p, 31, 1880, II. 36, 1884, II. 292.

[2] According to communications made to me by the Controlleur Arnout.

[3] Von Gaffron, S. 27.

tributary of the Sikajam), and on the river Katingan; further in Skadau, and on the river Limau (tributary of the Kapuas), between Samarankai and Meliau.[1] In 1852, antimony-ore, said to be derived from the island Mentigi (Karimata group), was sent to Batavia for examination.[2]

The investigations of Everwyn (1853–1857) had, however, a negative result. He, nowhere, found antimony-ore; and on the island Mentigi, he only found specular iron, and iron-sand.[3]

At Pinoh (on the river Melawi), however, he received a piece of antimonite, from a native chief; but he could not discover whether the specimen was derived from the upper river Melawi, or from the Pinoh. But the occurrence of antimonite in W. Borneo was hereby confirmed.[4]

During his investigations in the eighties, Van Schelle tried in vain to find antimony-ore. It was found that specular-iron had, in many cases, been mistaken for antimonite. In the basin of the Melawi, he obtained a number of mineral specimens from the natives; but there was only one piece of antimonite among them. This was said to be derived from the river Iban,[5] perhaps from the river Ella, where this ore is stated, by a Controller, to occur.[6]

Neither was anything found in the basin of the upper Sikajam, although antimony is found in the neighbouring state, Sarawak.[7]

Also the neighbourhood of Sinkawang, and the islands lying near the coast, were prospected for antimony-ore, but without result.[8]

---

[1] Van Lynden, W. 11, and Everwyn, W. p. 12 and 39.
[2] C. de Groot B. 22 and 23, p. 12 and 39, and W. 39, p. 58.
[3] W. 39, p. 64.
[4] W. 39, p. 31.
[5] Van Schelle W. 54, p. 82.
[6] Jb. v/h M. 1880, II. 36.
[7] Van Schelle W. 62, p. 123 and 145.
[8] Javaverslag 1883, I.

Thus we have positive knowledge of the occurrence of antimony-ores in W. Borneo, only in the basin of the river Melawi (Ella river ?), and in the upper river Sikajam.[1]

Antimonite (probably in veins) also occurs on the island Serasan (South Natuna group, about ten geographical miles north-west of Cape Datu). It consists of 44·5 per cent antimony-ore (=51·3 per cent. $Sb._2$, $S._3$), and 38 per cent, of veinstuff (quartz). It contains no silver.[2]

East Borneo.

No antimony-ores are known to occur here.

Sarawak.

Antimony-ores were discovered in Sarawak in the thirties by the natives. The ore was brought to market in Singapore, and as it was bought by Europeans at a good price, a vigorous trade sprang up. The sultan of Brunei forced his subjects to work the ore. After ten years the natives revolted, and the forced labour in connection with the raising of this ore, is said to have been the cause of the war.[3]

About this time James Brooke came to Borneo, helped the sultan of Brunei to repress the insurrection, and was rewarded by the gift of the state south of Sarawak.[4]

The occurrence of antimony-ore is distributed over the whole of Sarawak, *e.g.*, in the upper Sarawak district proper (Bidi, Busan, Jambusan, Piat, Grogo, Sikungit, Ahup, Gumbang); in the Sadong district (Sirin); near Marup, on the

[1] The natives seem desirous of obstructing investigations; thus, Van Schelle was shewn a piece of antimonite, found by a native in the Sikajam, but he was not allowed to indicate the locality.

[2] Jb. v/h. M. 1881, II. p. 243.

[3] Bleekrode B. 9, p. 109.

[4] Low N. 1; Ida Pfeifer (second journey round the world, I, p. 54 of the English edition).

Batang-Lupar river; on the rivers Pelagus Poi, Kanowit, and Silalang, tributaries of the river Rejang.

It occurs in workable quantities especially in Sarawak proper (Bidi, Busan, Jambusan, Piat, Grogo, Sikungit), where the easily accessible places have been worked; further in the basin of the river Rejang (Kanowit and Silalang).[1]

In the upper basin of the river Sarawak, Bidi, and Tudong are the chief localities.[2] The district is an undulating hill-land, with intervening broad valleys. Bidi also lies in a similar wide and unhealthy valley, surrounded by high mountains.[3]

According to Gröder,[4] clay-slates alternate here with sandstones, in places underlain by a dark limestone. Isolated mountains are elevated to a height of 200 metres above this hill-land, and consist, in part, of a limestone, similar to that already mentioned in part of porphyry.

The eruptive rocks are:—the porphyry, occurring in dykes, and white and dark quartzose rocks. The ore is connected with these eruptive rocks, and especially with the dark quartzose rock, in which it often appears in needles, or in coarse grains. The limestone is traversed by the ore bearing eruptive dykes, and at the junction is converted into crystalline limestone. In some cases, the irregular fissures expand into cavernous spaces, open in many places, or filled with stones. In these openings, which are to be regarded as the remains of veins that have been subsequently destroyed, round pieces of ore have been found.

A larger yield than from the veins is to be obtained from the loose pieces of ore (in part pure, in part mixed with

---

[1] Everett, N. 23.

[2] Low N. 1. Antimony-ores are found half sea mile = 0·25 geographical mile above the mouth of the delta of the R. Sarawak. Tudong lies nine sea miles = two geographical miles towards the mouth of the R. Lundu (Le Monnier, N. 40, p. 453 and 465).

[3] Boyle N. 11.

[4] Gröder N. 21.

quartz), which are to be found in the soil round the hills, mostly near the out-crop of the veins.

According to Everett,[1] the veins traverse the limestone, which, but seldom, shows any marked metamorphism. The vein-stuff is usually felsitic, but sometimes calcareous, and then rich in ore. The white felsitic vein-stuff sometimes passes over into a grey, hard, felsitic mass, with which the ore appears to be intimately mixed. The vein-stuff consists of antimonite, calcite, cerussite (black spar), in part intimately mixed, but the composition is very variable.

The veins in the Busan hills strike north-west and south-east. The dip towards the north-east is 20° to 50°. In the Djambsan hills the strike is east and west. The veins in Bidi have a high angle of dip.

The antimony-ores found are the following:—[2]

1. *Antimonite.*—In prismatic and fibrous masses, not auriferous. It occurs in boulders, at the foot of the hills, and as veins in the limestones. It is quite pure or mixed with quartz, and passes into antimony-ochre; some pieces are completely altered into ochre, which sometimes still shows the fibrous structure of the antimonite. The richest ores are those near Ahup.

Two antimony-ochres occur in Borneo:—Stilbith and Cervantit. Both consist of oxy-antimonious acid, the former being hydrated, the latter anhydrous. The purest variety contains 65 per cent. Sb.

2. *Native Antimony.*—In great pieces weighing as much as a pound. It has a granular and laminated structure, and a pure, tin-white colour. It has been formed by the reduction of antimonite, by the action of hot solutions. It occurs in the Alluvium, and in the cavities of the limestones; it is also scattered through the vein-stuff of the antimonite veins. The richest deposits of native antimony occur in the Busan hills.

---

[1] Everett W. 23, p. 23. [2] Frenzel, B. 38.

The following oxides also occur:—

Valentinite (antimony-oxide)—In radiate aggregates, pure white, and of an andamantine lustre (sometimes auriferous). It occurs in veins and in lumps weighing thirty to forty pounds in Alluvium. The richest deposits occur in the neighbourhood of the Busan hills (Busan, Piat, Paku). On account of the difficulty with which it can be reduced, it is one of the least valuable of antimony-ores.

Antimony-blende.—In radiate masses.

Sarawakite—Minute colourless or yellow crystals, with adamantine lustre, probably crystallizing in the Tetragonal system. The mineral is anhydrous, and is probably a compound of chlorine and antimony.

Associated more rarely with the antimony-ores, are:—Copper, arsenic, realgar, gold, and mercury.[1]

Sultanry Brunei.

Besides in Sarawak, antimony-ores are reported to occur in the river Barram (formerly belonging to the Sultanry of Brunei).[2]

Sabah.

Antimony-ores have been sought for in the territory of the British North Borneo Co. (in the Marudu valley and the basin of the river Labuk), but with negative results.[3] A specimen of antimony-ore, said by the natives to be derived from the R. Marudu, gave the first impulse to these investigations. There is little doubt, however, that in the course of years antimony-ores will be found here, as the geological relations are suitable for their occurrence.

Production.

We have the following data with regard to the yield in Sarawak.

---

[1] Everett N. 23, p. 10. [2] Everett N. 23. [3] Fr. Hatton N. 48.

In the forties, 600 to 1,000 tons of ore were annually exported to England. Up to 1849, 14,000 tons of ore were, in all, exported to Singapore.[1]

Between 1855 and 1877, the yearly production was 25,000 Ctr.[2]

According to Crocker's data, 25,000 tons of the value of more than a million dollars were raised for the Borneo Company, between 1859 and 1879.[3]

More exact details have been recorded from the year 1864.

TABLE SHOWING EXPORT.[4]

Year.	Tons.	Value in Pounds.	Amount of Antimony Ore.		Amount of Antimony Glance.		Amount of Antimony Oxide.	
			Tons.	Value.	Tons.	Value.	Tons.	Value.
1864	488	9·762	488	9·762	—	—	—	—
1865	463	9·260	463	9·260	—	—	—	—
1866	588	13·850	438	10·100	150	3·750	—	—
1867	7	3·000	7	3·000	—	—	—	—
1868	1·710	34·209	1·710	34·209	—	—	—	—
1869	1·444	61·385	1·444	61·385	—	—	—	—
1870	1·699	61·730	1·699	61·730	—	—	—	—
1871	1·278	51·690	978	41·190	300	10·500	—	—
1872	3·288	112·277	1·788	86·926	533	25·351	—	—
1873	2·009	99·869	—	—	1·667	88·197	342	10·672
1874	1·322	59·205	—	—	941	51·544	381	7·661
1875	1·568	70·050	—	—	1·091	57·200	477	12·850
1876	408	45·958	408	45·958	—	—	—	—
1877	469	35·550	311	13·050	93	10·850	65	1·650
1878	—	44·650	—	—	—	—	—	—
1879	—	58·665	—	—	—	—	—	—
1880	—	72·516	—	—	—	—	—	—
1881	—	88·255	—	—	—	—	—	—
1882	—	75·063	—	—	—	—	—	—
1883	—	66·572	—	—	—	—	—	—
1884	—	57·853	—	—	—	—	—	—
1885	—	27·638	—	—	—	—	—	—
1886	—	4·697	—	—	—	—	—	—

The greatest production is from the Alluvium (Jampusan, Piat): the veins are not very rich.

[1] Bleekrode N. 8.
[2] Frenzel B. 38.
[3] Crocker N. 34, p. 195.
[4] Everett N. 23, and by letter.

MERCURY.

Historical.

At the end of the forties, Von Gaffron, in speaking of his travels in south-west Borneo, mentions the occurrence there of mercury-ores in the drift-deposits, and his report on the same subject, from the gold-washing districts of Tanah-Laut, belong to the same period.[1] In Sarawak, this ore was made known in 1868, by the exertions of Messrs. Helens and Walters, of the "Borneo Company."[2] It occurs there in the mountain Tegora, on the right bank of the Sarawak river; also on the northern foot of the Bongo mountain-chain, which is 3,000 English feet high.[3] In 1873, it was discovered at Gading. In Western Borneo, cinnabar was discovered in 1879, by the Indian mining-engineer, Van Schelle, although it had long been reported to occur in Sambas.[4]

In Sabah, traces of mercury-ores were reported to have been found in the river Quarmote, a tributary on the right bank of the river Kinabatangan (east coast), apparently in an auriferous Diluvium.

It is not known whether mercury ores also occur in E. Borneo.

Occurrence.

Cinnabar is almost the only mercury ore that occurs in Borneo. Amalgam is only once mentioned as a rare mineral in the gold-drifts of the Tanah-Laut district.[5] Native mercury occurs at Marup, in Sarawak;[6] and mineralogists are in-

---

[1] Von Gaffron, S. 10, and S. 27.

[2] There is also a sketch map of Sarawak proper, and of the district of the upper Samarahan, done by them, giving localities for antimony and quicksilver ores.

Gröder N. 21, and Everett N. 23.

[4] Jb. v/h M. 1884, II. 292, and 1889 I. p. 91.

[5] Von Gaffron S. 10.

[6] Everett N. 23.

terested in the occurrence of calomel in small lustrous crystals in cavities in the parent rock of the ore in Sarawak.[1]

The ores are found in recent river sand, in Diluvial deposits, and in the parent rock. It is noteworthy that cinnabar and gold are associated nearly everywhere in the drifts. Cinnabar is often associated with iron-pyrites (Nanga Betung, W. Borneo; Gading, and Tejora, Sarawak), and with antimonite in the drifts (Nanga Betung).

In comparison with the mineral wealth of Borneo in coal, gold, and diamonds, the mercury-ores occupy a very subordinate position.

The greatest superficial distribution of the cinnabar is on both sides of the mountains separating Sarawak from the districts Montrado and Sangau, as well as the spurs sent off from them. But it is very unequally distributed: for while in Sarawak a considerable amount of cinnabar is raised, its occurrence in Montrado, etc., would not repay working.

South Borneo.

In some of the gold-washing districts of Tanah-Laut, amalgam is found associated with the gold. We possess no detailed information with regard to its occurrence, but it appears to be extremely limited.[2] According to C. de Groot's geological map of south-east Borneo, it occurs near Pleihari.

Mercury occurs under similar conditions in south-west Borneo,—namely, in the drift-deposits of the Lower Katingan and Kotaringin, in association with gold, platinum, copper, and tin-ore.[3] Here also we possess no exact details with regard to its mode of occurrence.

West Borneo.

In the west part of the island the occurrence of mercury is, with one exception, confined to the Chinese districts. It

[1] Frenzel B. 38, p. 302. [2] Von Gaffron, S. 10. [3] Ib. S. 27.

occurs at the southern foot of the boundary mountains and its spurs. Up to the present it has been found close to the boundary in the upper basin of the R. Sikajam and Sambas, and at the foot of the Bawang mountains, which lie in the district Montrado.

It has also been found on the river Miru and Bojan, in the neighbourhood of the R. Kapuas.[1]

The prospecting in this district was made in the eighties by the Indian mining-engineer Van Schelle, the first impulse being given to it by the discovery of grains of cinnabar in the gold-washings.[2] Most of the prospecting—washing the diluvial pebble-beds, small borings, sinking small shafts—led only to negative results. The superficial distribution of cinnabar in the diluvial deposits alone was made out, and only in one place were the prospecters fortunate enough to prove the occurrence of the ore in the parent rock. There can be no question of raising the ore, as it was evident that it could not pay working.

Bawang Mountains.

Grains of cinnabar occur in the gold-washing districts on the north-east and south-west foot of the Bawang mountains, in some small tributary streams of the R. Slakkau (S. Siam, S. Uduk, Djerenang) and in the R. Ledo (which empties itself into the R. Sambas (S. Sekire, Hansan, Lumar). Preliminary investigations, however, showed that the distribution of cinnabar in the auriferous drift was very restricted, and similarly the quantity found was very small, but the richest deposits and the biggest pieces were found in Sekire. In addition to the gold-flakes, the diluvial deposits contain more or less rounded grains of cinnabar, varying in size from a pin's head to a pea, and quite pure; further

[1] Van Schelle W. 42.

[2] Near Nanga Merau, a pebble of cinnabar, weighing 25·5 grms., was found in a tributary brook of the R. Sikajam. (Jb. 1886, II. p. 129).

small pebbles of quartz, pieces of slate, pieces of hæmatite, limonite, and clay-iron-stone (laterite), and isolated, much weathered pebbles of an eruptive rock (porphyry?) imbedded in a yellowish-red sandy clay. Cinnabar is only found *in situ,* as already mentioned, at Sungei Sekire, where it occurs disseminated in a clay-phyllite.

This phyllite, which forms a low hill-land, is of a reddish or bluish colour. It is altered into laterite, constituting a red ferruginous clay, in the upper layers of which are ferruginous concretions, and blocks of a cellular laterite.

On the other hand no cinnabar was obtained by washing the finely-stamped clay-slate of S. Siam.[1]

Upper Basin of the rivers Sikajam and Sambas.

Here also the first impulse to investigation was given by the discovery of grains of cinnabar in the gold-washings. Some prospecting for cinnabar was done in 1875 by two Englishmen coming from Sarawak, but they were obliged to return on account of illness. Cinnabar in grains varying in size from a pin's head to a bean, occurs in the gold-bearing strata in the neighbourhood of Kajan. The pebbles of the pebble-bed consist of gabbro, clay-slate, quartz schist, and hornblende-andesite. No cinnabar was found *in situ, i.e.,* in the parent rock.

Similar relations are shown near Siluas. Here also the cinnabar was found only in the drift, and the probable parent rock, a clay-phyllite, yielded no ore on examination.[2]

Upper Basin of the Kapuas.

Grains of cinnabar were found in the gold-bearing Diluvium of the water-courses of the Miru, Betung, and Bojan, in the neighbourhood of Manga Betung, in the basin of the Kapuas. The pebble-bed contains, besides fine quartz sand,

[2] Jb. 1884, I. p. 123, and Ib. 1883, II. p. 85.
[1] Jb. v/h M. 1884, II. p. 261.

clay, fragments and boulders of quartz, gold, and cinnabar in rounded grains, a small quantity of antimonite, iron-pyrites, magnetite, and spinel. The cinnabar amounted to 0·890 kilogrammes per cubic metre.[1]

The ore was not found in the parent rock, and Van Schelle believes that it is derived from quartzose veins, containing gold, cinnabar, and antimonite.[2]

Sarawak.

The mercury ores of Sarawak occur in the upper basin of the R. Sarawak; further between the Bongo mountains and the boundary; in the districts Samarahan and Sadong, near Marup and Kumpang, on the R. Batang-Lupar, and in the parent rock, especially near Tegora and Gading.

The parent-rock is a clay-phyllite alternating with sandstones, faulted, and much metamorphosed, *i.e.*, altered into laterite. The sandstones are indurated (silicefied); but the phyllites have decomposed, yielding a clay which contains fragments of black slate and of quartz. These beds, the age of which is probably Devonian, as Van Schelle has shown in W. Borneo, are overlain in Sarawak by a sandstone system (Tertiary) of great thickness.

The cinnabar does not form a regular vein, but rather a vein-like impregnation of the parent rock, especially of the phyllite. It occurs in threads of six inches thickness, in patches and nests, or as films on the joint-faces, often accompanied by marcasite and barytes. The cinnabar of Gading is distinguished from that of Tegora by its crystalline structure, and by a greater amount of quartz in the veinstuff; further, by being associated with much iron-pyrites.[3]

---

[1] Jb. v/h. M. 1880, II. p. 15.

[2] On Crocker's map cinnabar is only indicated near Tegora. Quicksilver was sought for in vain in the Ular-Bulu mountains (district Mirkah in Sarawak).

[3] Everett N. 23 ; Gröder N. 21.

Near Gumbong (Sarawak), Van Schelle found silky, thinly laminated, clay-phyllites, impregnated with cinnabar, and this ore deposited in thin threads along the joints.[1]

Production.

Sarawak is, up to the present, the only state in Borneo where cinnabar is raised. The chief centres are Tegora and Gading. The greatest yield is furnished by the rich drifts on the flanks of the hills Gading and Tegora. Much is also obtained from the great blocks which lie scattered at the foot of the mountains.

The latter have yielded many hundredweight; while the clay-phyllite has not been very productive.[2]

With regard to the annual yield and export I have only been able to obtain a few very deficient data.[3]

Year.	Export value in pounds.
1868,	2·547
1869,	47·125
1870,	22·692
1871,	24·992
1872,	71·583
1873,	86·355
1874,	101·344
1875,	81·800
1876,	108·050
1877,	110·000
1878,	34·050
1879,	76·620
1880,	66·300
1881,	64·490
1882,	15·250
1883,	40·300
1884,	3,550
1885,	32·652
1886,	31·742

[1] Van Schelle W. 56, p. 85. [2] Gröder N. 21.
[3] Everett's communication, and N. 23.

Analyses.[1]

There exists only one analysis from Nanga Betung (W. Borneo).

The sample contained:—

Mercury,	... ... 81·50	} 94·54.
Sulphur,	... ... 13·04	
Magnetite,	... ... 5·00	
Sand and pyrites,	... ... 0·46	
Gold in traces,	... ... —	
	100·00	

Another sample gave:—

Cinnabar,	... 89·5	per cent. (77·1 per cent. of mercury).
Iron-pyrites.	—	
Magnetite.	—	
Antimonite.	—	
Earthy matter,	... 10·5	„
	100·00	

Cinnabar from the neighbourhood of Longan (Bunut, Upper Kapuas, in W. Borneo), contained 0·01 grm. argentiferous gold in 30 grms. of the ore.[2]

IRON

After gold, diamonds, and coal, the iron-ores occupy the most important position among the useful minerals of Borneo, both with regard to distribution and economic value to the natives, at least in former years.

The wealth of Borneo in iron, and the means of converting it to useful purposes have been much discussed. But, unfortunately, all investigations have led to different

[1] Jb. v/h M. 1880, II. p. 91 and 15. [2] Dr. Crétier W. 40.

results. There is no doubt about the wide distribution, but it has been shown that iron-ore-deposits will not pay working, at least on the part of Europeans.

The iron-ores are most widely present, as clay-iron-stone, and as lateritic iron-ores. Red and magnetic iron-ores have a more local occurrence.

South Borneo.

In the first place the iron-ores of Tanah-Laut[1] (red iron-ores), should be mentioned. Von Gaffron[2] was the first to discover iron-ores in Tanah-Laut. This he did near Tambaga and at other places, during a topographical survey in 1844. Ten years later (1854), some prospecting was done here by the Indian mining-engineer Rant,[3] and in 1883 the Indian mining-engineer[4] submitted these ores to a fresh investigation.

The ores occur to the south and to the south-east of Tabanio in isolated hills, or hill-ranges, which extend parallel to the mountain-land (with a general strike of north-north-east and south-south-west) for about fifteen geographical miles from the shore.

The richest deposits occur in the hill-range Pamatang. near Tambaga. At this place large and numerous blocks of ore lie on both sides of the way, and the neighbouring brooks are full of them.

The deposit, which is here and there enclosed by a porphyritic greenstone, is about 1,000 metres long and 200 metres wide, and has the same direction as the latter. According to Rant the south-west part of the hill-range is richest in ore.

---

[1] The localities in Tanah-Laut are well marked on C. de Groot's geological map of Southern Borneo. (See Jb. v/h M. 1874, II.)

[2] Von Gaffron, S. 15.

[3] H. F. E. Rant S. 20. One of his tasks was to collect 15,000 kilos. of ore for smelting.

[4] *Java Courant* 1883, IV.

The ore is hæmatite, in places strongly magnetic; it is crystalline, and steel-grey with a red streak. It becomes tarnished by the action of the weather, assuming bright colours; it also becomes porous and cellular. According to an analysis carried out by Professor Mulder in Holland in 1847, it is a very pure red iron-ore, with a small admixture of magnetic iron-ore. Foreign substances present—silica, lime, magnesia, potash—amount at the most to 2 per cent. phosphorus and sulphur are absent. The ore contains 98 per cent. iron-oxide, or 68·6 per cent. iron.[1]

On the south-south-west of this hill-range there is the hill-range Sungei Sangar, which also contains the same ore, although not in such quantity.

On the north-north-east of the same hill-chain, hæmatite occur in great blocks in the neighbourhood of the gold-mines of Pontein, at the foot and on the declivities of the hills Gunong Djidjekan, Pontein belombang and Batu betonkat; but they are not so numerous as near Pamatang Damar.

On the sea-coast, about seven kilometres south of Tabanio, a hill of twenty-five metres circumference, and 5·0 m. height, rises up from a swampy ground near Talo. This consists of weathered quartzite, with numerous blocks of red iron-ore and many crystals of iron-pyrites.

To the south of this place there is also a small hill of red iron-ore, weathered at the surface. The neighbouring rock is gabbro.

Between Teksun and Pleihari, near Benua tengga, red iron-ore, enclosed in quartz blocks, occurs in an isolated hill (fifteen metres in height and forty metres in diameter).

None of these occurrences are workable, according to Hooze.

Clay iron-stone occurs as concretions in numerous places in the different coal-bearing strata, as has already been shown by

[1] Rant's opinion that the iron-ore deposits were worth working, led to the formation of a private company (in the fifties) for working them, but it came to naught. (See Mining Operations.)

Horner[1] and Schwaner.[2] These concretions are mostly present as layers in the hard clays. In the Eocene beds they consist of argillaceous spherosiderite, in the upper beds of argillaceous brown iron-stone.

These nodules of clay iron-stone often attain the dimensions of a man's head; they are very hard and rich in iron. In the interior there is generally a cavity, with some iron-ochre, crystalline brown iron-ore, and sometimes the cast of a bivalve.

Clay iron-stone is also widely distributed in western S. Borneo, as Von Gaffron[3] showed in the forties. Thus it occurs in the bed of the R. Kalong (Sampit district), on the R. Bessi, and at other places in Pembuang; also in the upper course of the R. Djelei, near cape Waringin, near Selangkan, in the mountains Senampungan, Dauhu and Sekalan. The beds extend as far as Matan. Further in the upper course of the Lamandan (a tributary of the Kotaringin), on the R. Plantikan, in the neighbourhood of Koba and Bajan, on the rivers Tjina-bawang and Toat. But these are in part also beds of magnetic iron-ore, this ore also occurring in great blocks six to eight feet deep in the Alluvium, from which they are dug out by the natives.

The tools used by the natives (in the forties) were hammers made of greenstone and wood. The iron-blocks were first heated in order to make them fracture. The thickness of the seam is about three feet and these layers are distinguishable according to the degree of weathering.

Beds of red iron-ore also occur in the R. Samba, and its tributary Mantikei (Manteka), which are affluents of the Katingan.

West Borneo.

Already at the end of the forties it was reported that iron-ores occurred in the R. Balimbang,[4] further in the upper

---

[1] Horner S. 2.

[2] Schwaner S. 17, I. p. 60.

[3] Von Gaffron S. 27.

[4] W. 6.

Melawi and Seberuang (tributaries of the Kapuas), in the river Siduh, and especially in the state Palo.[1] On the banks of the Siduh Everwyn found, in 1857, abandoned smelting hearths and slag; further, clay-iron-stone included in the sandstones of the neighbouring hills.[2] Similar clay-iron-stones are also found in several other places; thus, for instance, on the small island of Bessi, to the east of Karimata, where conical and nodular clay-iron-stones are interbedded with shales, sometimes traversing them like a net-work.[3]

Marsh iron-ore also occurs near Batu bessi on the R. Pawan in Matan, and again near the sources of the R. Pendjawaan,[4] and on the R. Swait in the neighbourhood of the R. Kapuas.[5]

Brown iron-ore occurs in veins. For instance, a quartz-vein with brown iron-ore traverses the granite on the island Karimata. This vein is worked for iron by the Chinese.[6] A similar vein occurs in slates in Kandarwangan.

Specular iron-ore occurs in veins of sixty to eighty-five centimetres thickness in the old slates (strike south-east and north-west, dip ninety degrees), near Padjilu, between Mandor and Montrado.[7] The vein consists chiefly of a fine-grained aggregate of tabular crystals of iron-pyrites, and probably also some copper pyrites, a little magnetite and tourmaline.

Specular iron also occurs in nests in clay-slate, between Siluas and Sidin (upper basin of the R. Sambas). The lenticles are some decimetres thick, and are often united by threads. The specular iron which is sometimes accompanied by pyrites, consists of an aggregate of small, thin plates.[8]

It is worthy of note that iron has also been found in the native state, in a grey quartz-schist. (R. Sikajam in W.

[1] Everwyn W. 39, p. 11.
[2] Ib. p. 77.
[3] Ib. p. 63.
[4] Ib. p. 62.
[5] Ib. p. 24.
[6] Ib. p. 63.
[7] Ib. 1885, II. 183.
[8] Van Schelle, Jb. v/h M. 1883, II. 89.

Borneo). The amount of iron is 2·86 per cent.[1] Under the microscope no crystals are visible, but only small dark spherical bodies.[2]

North Borneo.

Iron-ores have here a wide-spread occurrence, mostly in the form of concretions of clay-iron-stone in the coal-bearing strata.

Thus, they occur on the island of Labuan,[3] in the shales of the coal-district; sometimes in regular beds The interior of the nodules is occupied by crystallized calcite or arsenical pyrites. Also in Sarawak[4] iron-ores have a wide distribution; but they are of no economical importance for Europeans; they consist partly of pure iron-oxide, magnetic and with metallic fracture, in greater part, however, of argillaceous, hard, often slaggy iron-stone, sometimes occurring as pebbles in the alluvium, or in the auriferous drift. These are laterites.[5]

The richest deposits are to be found in the district Ridjang[6] (sixty to eighty per cent.).[7] In Brunei, they are known to occur in the basin of the R. Barram.

In Sabah[8] they are widely distributed in the Tertiary beds. They occur near Kudat (Bay of Maruda), also on most of the hills on the R. Labuk, between Tunder batu and Punguh; further near Pinunguh, on the river Kinabatangan, in the coal districts.

---

[1] By treating the powdered rock with the magnet superficially oxidised iron was obtained, which, when ground in the agate morter, assumed a metallic lustre; and on treatment with hydrochloric acid liberated hydrogen.

[2] Dr. Crétier n. T. v. N. J. 1883.

[3] J. Motley N. 7.

[4] Low N. 1.

[5] Everett N. 23, p. 20.

[6] Burns N. 3.

[7] St. John N. 9

[8] Hatton N. 48.

East Borneo.

Iron-ores are said to occur in Kusan[1] (probably clay-ironstone), also in the interior of Kutei.[2]

Iron-sand in the Diluvium and Alluvium.

A fine iron-sand is always present in the Diluvium and Alluvium, and always accompanies the gold in the drifts. It is a mixture of chrome-iron and magnetite sand, and is derived from rocks rich in iron, *e.g.*, from the serpentine on the Riam-Kiwa and Riam Kanan rivers;[3] from the syenitic rocks near Sukadana,[4] in W. Borneo, where much iron-sand occurs in the Diluvium surrounding these mountains; and, further, on the shore of Pulu Laut, and of the neighbouring Pagattan, where it is also derived from serpentine. Here the iron-sand occurs chiefly in rounded granules, and only occasionally in larger aggregates of several ells length, and about half an ell thickness.

The following analysis is by Rost von Tonningen:—

23·434	Chromite.
63·550	Oxide of iron.
9·771	Sand.
2·987	Alumina.
99·742	
0·258	loss on ignition.[5]
100·000	

This "black-sand," which is known as "puja" among the gold-diggers, occasionally contains some small crystals (up to six milometres in length) of limonite and hæmatite.[6]

[1] Nieuwkuyk E. 12.
[2] Bock B. 44.
[3] Verbeek, S. 41, p. 45.
[4] Everwyn W. 39, p. 59.
[5] Huguenin S. 38.
[6] De Groot S. 23. p. 34.

The cementing material of the Diluvial conglomerate is often so rich in iron (present as brown iron-ore), that it is used for smelting purposes in S. and W. Borneo. Brown iron-ore occurs, for instance, in the last-named Residency, near Cape Gangsa, near the mouth of the little river Bakkon, in a bed of conglomerate, which, in former times, was smelted by the Chinese.[1]

THE IRON INDUSTRY OF THE NATIVES.

The art of iron-smelting and of the manufacture of steel is one of great antiquity among the natives of Borneo, as well as in the neighbouring islands of the Indian Archipelago. Whence they derive their knowledge is unknown. Its origin is the subject of fabulous stories.

The material most used is the argillaceous spherosiderite, which, as already mentioned, is often present in the coal-bearing beds. Usually it is taken from the most accessible spots in the river-beds. In these places the ore has been more or less subject to a chemical change, *i.e.*, the clay-iron-stone, is, in part, converted into argillaceous brown iron-ore, and is then rendered more easily workable. But the ore is also obtained by sinking small shafts.

Hearths for smelting iron were in existence throughout the whole of Borneo as early as the middle of this century, In the south of the island many of them existed in the district Siang Murong.[2] But an especial fame for the practice of this art was enjoyed by the inhabitants of the district Dusson-Ulu; and iron-smelting was the chief employment of the inhabitants of the R. Montallat.

Ten furnaces were being worked here during the forties, and the iron-trade was widely renowned.[3]

Similarly in the western parts of S. Borneo, in the districts

---

[1] Everwyn W. 39. [2] Schwaner S. 16, I. 91, 127.
[3] Ib. I. 109 and 115.

Katingan and Kotaringin, a great number of smelting furnaces were kept going during this period, the iron-trade being especially flourishing in the first-named district. The iron-ores were derived from the R. Sampa and its tributary, the Mantikei. Five thousand parangs (blades) were sold (at 0·50 florins) here annually during the forties.[1]

In W. Borneo smelting furnaces existed in the southern states, on the R. Bakam, in Kandawangan; further, according to E. Müller, on the river Siduk in Matan and Simpang[2] and on the R. Palo.[3] In N. Borneo a number of furnaces existed on the R. Rijang.[4] In this district it was the Kayan race who especially excelled in the art.[5] In the fifties the native industry began to decline. Iron was still melted,[6] but in smaller quantity than before, and many of the furnaces had ceased to work.[7] The smelting was carried on here by 300 to 400 Chinese.[8] The cause of the decline was the competition with European iron, which was sold cheaper in Borneo than the native iron could be produced. Since the seventies iron-smelting seems to have entirely ceased, at least, such are the reports from W. Borneo.[9] At the time of my stay in Borneo in the beginning of the eighties, the furnaces on the R. Montallat and elsewhere, were no longer being worked.[10]

In describing the method of smelting, I am obliged, in consequence of this, to follow Schwaner, who witnessed the operations in the forties.

The cylindrical blast-furnace has a height of three feet four inches, and a circumference of ten feet. The shaft has the

[1] Schwaner, II. 145.
[2] Veth W. 17, p. 17, p. 125 and 135.
[3] Everwyn W. 39, p. 79.
[4] Burns N. 3.
[5] Everett N. 23, p. 20.
[6] Everwyn W. 39, p. 25.
[7] Ib. W. 39, p. 79.
[8] W. 20a.
[9] Van Schelle Jb. v/h M. 1880, II. 37; 1882, II. 102; 1884, I. 293.
[10] Schwaner S. 16, I. p. 109.

form of a parallelopiped (eight by six inches), and becomes wider towards the top, having a pyramidal form. The smelting hearth is twenty-five inches long, nineteen inches wide, and nine inches high.

The material of which the furnace is constructed is a yellow clay, which is obtained from the banks of the rivers.

This material, having been kneaded and purified, is pressed in a cylindrical cork mould, having the dimensions of the furnace. It is allowed to dry for a month or more. The mould is then removed, and the furnace bound round with Spanish cane (rattan), in order to give it greater strength, and to provide against bursting. The drying process is completed by a small fire.

The smelting only lasts one day. The floor of the hearth is first covered with powdered charcoal to a depth of two inches, in the middle of which a hole is made, which serves to collect the iron. The tapping-hole is closed by clay, a semicircular hole being left to let out the slag. The blast apparatus consists of a hollow tree-stem, five feet five inches high, and three inches in circumference, open at the top, and closed at the bottom. Directly above the floor there are three openings on the same level, and close to one another. These openings are intended for the insertion of three bambo tubes, twenty-nine inches in length, through which the blast has access to the tuyers and to the furnace. The tuyers are made of baked clay. They are eleven inches in length, and narrow considerably in the part opening into the furnace. In the bellows there is a valve, which is made air-tight by feather down. It is worked by hand.

Burning charcoal is thrown from above into the furnace, and a gentle blast produced, sufficient to cause the charcoal layer to glow. The furnace is then filled to two-third of its height with wood-charcoal. The ores are first submitted to a roasting action, by piling them up in layers between wood, igniting the pile, and allowing it to burn for one day. The ore is then broken into pieces of the size of a nut, mixed with charcoal in the proportion of 1 to 10, and thrown into the furnace. Usually two hours and a-half suffice to sink the ore, after which more ore and coal are added.

The slag is run off at intervals of twenty minutes, the tuyers being removed, and the blast stopped for five minutes, while the slag is running off. A drawback to this method is that a large part of the iron goes into the slag.

As soon as all the fuel is burnt, the tüyers are taken out, and the stopping of the hole into the hearth removed. The iron, which is in the form of a viscid, molten mass, is then drawn out of the furnace by means of wooden tongs, placed on a finely broken slag, and beaten with wooden hammers until it becomes smooth.

Such a mass, weighing forty-five pounds, represents a day's work for four men, and costs two florins. It contains much slag, however, and having been divided into ten parts, has to be several times re-melted and beaten with hammers until it is pure enough for smithy work.

While iron-smelting has almost entirely ceased, this is not the case with the smithy work. Weapon-smiths still exist, who manufacture excellent blades. Especially worthy of mention are the works of the great industrial place Negara, in S. Borneo, of which the "Negara blades" have a wide-spread reputation.

The natives prefer their own iron to the European, as experience teaches that the keeness and durability of these weapons are superior to those of European manufacture.

COPPER.

HISTORICAL.

The occurrence of copper was first mentioned, in the year 1846, by Weddik, the Governor of Borneo.[1] It was

[1] Everwyn W. 39, p. 11.

stated to occur as native copper in the auriferous drifts at certain places in the Chinese districts in W. Borneo; *e.g.*, near Sebawi, in the state Sambas, near Budok, and in the Tampi mountains, near Montrado. But its occurrence has only been confirmed for the last-named place. The gold-washers, Chinese and natives, must, however, have been acquainted with copper ores for a long time, as they found native copper sometimes associated with the gold-sand, and occasionally in auriferous quartz-veins, together with iron-pyrites. The latter mineral, which the natives call *mas orong* to distinguish it from gold (*mas betul*), could not be distinguished by them from copper-pyrites; and besides they could make no use of it. A sample of this ore was sent to Batavia from the R. Peniti (Tampi mountains). Thereupon Van Deventer, an officer in the engineers, was commissioned to visit the locality, and found that copper-ore was a bye-product in the gold-washing.

This place was visited in 1854 by the mining-engineer Everwyn; and in 1857 copper was again sought for near Budok, but with no results of any importance.

Between 1858–1861, a private company undertook to prospect for copper, and the investigations were conducted by a mining-engineer. Copper ores were found at many places, but nowhere in workable quantity, in consequence of which the projected mining operations were not put into execution (See Mining Operations).[1]

Occurrence.

The copper-ores occur in the river sand of present water-courses, in the diluvial deposits, and *in situ*. Copper-ores have been found, up to the present, only in the Chinese districts of W. Borneo, and in Sarawak and Sabah in N. Borneo; but nowhere in workable quantity. The copper

[1] C. de Groot B. 22.

ores are:—Copper-pyrites, copper-glance, black copper, red copper, malachite, and native copper.

West Borneo.

In W. Borneo, copper-ores are only known to occur in the Chinese districts. The ore is pretty uniformly distributed in the neighbourhood of Mandhor; further, in the neighbourhood of Montrado, and near Budok.

Near Mandhor twenty-seven different localities are known in an area of four square geographical miles, but only in fourteen places was the ore found *in situ.*[1]

Occurring in the river-deposits, native copper is found everywhere in greater or smaller quantity in the neighbourhood of the drifts, or in the place of original formation (Tampi mountains, Brook in Budok, R. Duri-Ulu rising in the hill Bendu).

In the drift the copper also occurs as native metal (in the gold-washing districts near Budok, in the Tampi mountains, in the mine Liu-lian-tu, in the neighbourhood of Mandhor, near Palomin, in the neighbourhood of Montrado.[2]

It is never found far removed from its place of formation, so that we have thus an indication where the parent rock is to be looked for.

The quantity of the ore varies according to the locality. Near Palomin,[3] 161 grms. of copper occur in a cubic metre.[4] In the mine Liu-lian-tu so much copper is said to have been obtained in gold-washing in the early years of this century, that in Mandhor there was some idea of utilizing it for

---

[1] Everwyn W. 33 p. 137.

[2] Ib. W. 33, p. 138.

[3] A cuprifereous sand from a spring near Palomin was found to be separable, by sifting, into two parts. A coarse material, weighing 905 grs., and containing 75·0 of copper, and a fine material, weighing 1,105 grs., with 46 per cent. copper (Jb. v/h M 1881, II. 247).

[4] Jb. v/h M. 1883, I. p. 77.

coinage. These intentions were frustrated, however, because they could not get the copper sufficiently pure, and did not understand how to work it.[1]

Auriferous sand from old gold mines at the foot of the Tampi mountains, yielded on analysis 1·5 per cent. of copper (of which a little was present as native copper, the most as copper pyrites, then red copper-ore (cuprite), and copper-indigo); further, gold containing traces of silver, iron-pyrites, quartz, and felspar.[2]

Occurring in the place of formation, copper-ores are found in disseminated particles and in veins, both in slate and granite, and only exceptionally in argillaceous sandstones (between Mandhor and Senaman). Veins of pure copper-ore do not occur. The gold and pyrites-bearing quartz veins only occasionally contain copper-ore, and the latter are only exceptionally associated with galena and zinc-blende (mines Salothong, Nji-tu-kong, Liu-lian-tu, Ko-pie-thew, and a gold mine near Mandhor).

Lodes of any thickness and extent are of rare occurrence. In almost all cases they are small veins, traversing the country rock in all directions. The latter is also usually impregnated with finely-divided ore, or the ore is deposited in it in nests (neighbourhood of Montrado).

Thus in the Tampi mountains (mine Wang-phin-san) the clay-slates are traversed by a zone twelve metres wide which is laden with ore. The weathered rock is impregnated with iron-pyrites and copper-pyrites, and traversed by several small veins of ore. In this case also the veins were found to die out at small depths.

True veins are as little to be found here as in the Tampi mountains. The same relations are found near Salothong, but with granite as the country rock. The latter is laden with ore throughout a zone of five metres width. The ore traverses the rock in small veins, or is scattered through it in

[1] Everwyn W. 33, p. 121. [2] Maier W. 13.

nests and impregnations. At greater depths the quantity of ore diminishes.[1]

In the neighbourhood of Skanah the granite is traversed by veins (0·6 metre thick) of chlorite, containing copper-pyrites and blende. Thicker veins appear only to occur in the neighbourhood of the deserted gold mines Man-fo-pie and Ko-pie-theu. Numerous pieces of vein-quartz, impregnated with copper pyrites, are scattered over a clay-slate district. The veins appear to be very rich in ore, for some of the veins consisted almost entirely of copper-pyrites. Details are not known, as the work had to be stopped on account of the unfavourable conditions.

Worthy of note is the occurrence in an argillaceous sandstone; the latter is traversed by small veins containing pyrites and copper-pyrites.

Sarawak.

In Sarawak copper occurs in Upper Sarawak, not far from the boundary, but only in unimportant traces. It also occurs in small quantities, as malachite and azurite, accompanying the antimony veins in Busau. The attempt to work these deposits was soon given up on account of their poverty.[2]

Sabah.

The prospecting for copper done by F. Hatton in Sabah[3] led to no practical result. The investigation was occasioned by samples (among which was native copper) shown by the natives. Copper-pyrites was found scattered through a quartz-vein (Kinoram) and accompanying iron-pyrites in a quartz-vein (G. Tambayukon) which probably traversed serpentine. Copper-pyrites was also found in small quantities

---

1 Everwyn, W. 33 and 21.

2 Everett, N. 23, p. 21, and Gröder N. 21.

3 Hatton N. 48, p. 82, 92, 94, 221, 249, 251, 252.

in a calc-spar vein, containing abundant iron-pyrites, and traversing a compact limestone (Tambayukon). R. M. Little[1] also mentions copper-pyrites between the pebbles in the Upper R. Tampassuk, on the south-east flank of the Kinabalu mountains; it is not stated whether veins of the ore also traverse the limestone in this place, but it is probable.

The most widely-distributed of the copper-ores which occur here is copper-pyrites; then copper-glance, which occasionally is the only representative of the copper-ores (mine Wang-phin-san, in W. Borneo).

Native copper was only found in one place (Salothong), together with red-copper (cuprite) in the solid rock. Black-copper, red-copper, and malachite also occur in small quantities.[2]

SILVER.

Silver-ores were discovered in 1881, in Sarawak. The vein, occurring near Bau, was a rich one; but it was worked out in two years, or at least would not pay working after that time. In 1882, 1,387 tons ore, valued at 67,227 dollars, were exported. In 1883 only fifty-two tons of ore valued at 3,696 dollars were exported. In the following year the export appears to have ceased altogether, since it is no longer mentioned.[3]

In W. Borneo the natives report that silver-ores occur in the rivers Spauk and Skadau. But samples of these could not be obtained. Perhaps there has been some mistake here as the natives include the antimony ores under the term *Batu perak* (silver-stone).[4]

Silver-ores are said to have been quite recently discovered in Dent-Province in Sabah.[5]

---

[1] *British North Borneo Herald* 1887, N. 7.

[2] Everwyn W. 33, p. 141.

[3] Everett N. 14 and Notes. Jb. v/h M. 1884, II. 291, and 1886, II. 129 and 130.

[4] Jb. v/h M. 1880, II. 35.

[5] *British North Borneo Herald,* 1888, I.

LEAD AND ZINC.

These ores are known both in E. and N. Borneo, but they are only of theoretical interest, as they will not pay working.

Occurrence.

West Borneo.

Lead-ores were first found here in the year 1871, in the bed of a tributary of the R. Kandawangan, not far from Marau. The samples examined in Batavia showed that the ore in part consisted of pure galena (81·02 per cent. lead and 0·076 per cent. silver), in part of zinc-blende, associated with galena and iron-pyrites.[1]

Prospecting undertaken in 1878 showed that the ore occurred in irregularly shaped and unworn pieces up to 1·5 metres in diameter, in the superficial beds of a clay-slate weathering to clay. At greater depths the slate was free from ore. It is probably only a local occurrence in nests. The total quantity of ore was estimated at 4 to 500 kilogrammes.[2]

In prospecting for tin-ore in the neighbourhood of Tanah-Zoroh, in the state Kandawangan, lead-ore was found in the eighties. It consists of galena and iron-pyrites (silver 0·03 per cent.; no gold or copper). Further investigations were not carried on.[3]

Lead-ores were also found at a few places, in the Chinese districts; but these were of little importance.

A sample of ore from a vein of auriferous pyrites was derived from Silense, south of Benkajang. It contained 60 per cent. vein-stuff, 7·56 per cent. lead as galena, further, arsenic and iron-pyrites. The gold amounted to sixteen grammes per ton of ore; silver and copper were found in traces,[4]

---

[1] Jb. v/h. M. 1872, I. 260; 1874, I. 171; 1879, I. 91 and 113.
[2] Le Roi W. 41.
[3] Jb. v/h. M. 1885, II. p. 112 and 332.
[4] Jb. v/h M. 1874, II. 325.

Lead-ores were also sought for in the neighbourhood of Tandjang, near Montrado. They were first found in an auriferous vein in the solid rock (*Kong*). The slates are seen to be traversed by a lode, 0·5 metre thick (dipping vertically, and striking north and south). The lode consists of quartz with a little galena and iron-pyrites. The middle portion is formed by a band of ore, 0·1 metres thick, consisting of an aggregate, of galena and pyrites. This occurrence appears to have been formed by the infilling of a fissure of no great extent.

The ore consisted of:—

Galena,	...	...	48·40 per cent.[1]
Vein-stuff,	...	...	34·26 „
Pyrites,	...	...	17·34 „

Finely divided galena was also found between the pebbles, in a brook near Mandhor. It was shown by prospecting that galena and zinc-blende occur as local impregnations in the clay-slates of that neighbourhood.[2]

East Borneo.

Lead-ores also occur in the interior of the state Berau.

Blocks of ore, of varying size, were found lying at the foot of hill, fifty to sixty metres high, on the Sungei Goanggih, five and a-half day's journey above Gunong Tabor, a tributary on the right bank of the R. Mahan, which flows into the R. Segah (a tributary on the left bank of the R. Berau). In 1877, Ohlmeyer brought away 100 kilogrammes of this ore with him, and in 1882 an Englishman did the same.

The ore consists of galena with 0·017 per cent. of mercury, and a little zinc-blende.

Detailed information with regard to this occurrence are not available.[3]

---

[1] Jb. v/h M. 1881, I. 245. [2] Van Schelle W. 52

[3] Jb. v/h M. 1884, II. 313–342.

North Borneo.

In Sarawak some small lodes of galena were discovered near Bau in the eighties, but they were not workable. That galena also occurs in Bidi has been maintained but not proved hitherto.

The antimony veins also occasionally contain black spar; sometimes the antimony-ore disappears, and is replaced by lead-ore.[1]

TIN.

If we summarize the reports which treat of the occurrence of zinc-ore in Borneo, we are driven to the conclusion that this ore has a rather considerable distribution; but taking into consideration the positive facts alone, the amount of the ore is reduced to a minimum.

It has often happened, and still occasionally happens, that the widely-distributed black magnetite-sand is mistaken by the natives and by Europeans for tin-sand.

The only positively known occurrence is that near Abut, in South-western Borneo, where a small quantity of tin-ore has been found in auriferous drift.

In Dutch Borneo the tin-bearing (?) districts are in the states Simpang, Matan, Sukadana, and Kottaringin.

Already in the twenties G. Müller mentioned the occurrence of stream-tin in the first-named states,[2] and Von Gaffron reports that stream-tin occurs in some rivers near cape Silaka, probably swept there from Matan; thus along the R. Pesaguan, in the mountain Kläsi, he speaks further of tin-bearing clay-slates and gneisses in the same place.[3]

Tin-ore is said to have been long known on the R. Katuntong, a tributary of the river Pawan; and according to

---

Everett N. 23, p. 21-23 and notes. Veth W. 17, I. p. 125-128.
[3] Von Gaffron S. 27.

G. Müller it was regularly worked by the Chinese on the R. Kandawangan, but only for a short space of time.

In 1852 several samples of ore were sent from these districts to Batavia for examination. Only one consisted of tin-stone, it was derived from a small gold mine near Abut, (north of mount Belaju in the basin of the R. Pesaguan).[1]

Everwyn in his investigations in the fifties nowhere came across tin-ore; but he considers it possible that it may occur near Abut, a point which can only be settled by detailed investigation.[2]

In recent years tin-ore has been sought for in the Kandawangan (district Tanah-Zoroh), by the Chinese; but the investigation was of no great duration. Only a black metallic sand was found, which consisted of galena, iron, and copper-pyrites.

Stream-tin[3] are said to occur in the eastern districts of Sarawak; similarly in the Bintulu and other rivers, thus in a river emptying into the bay of Marudu to the west of the Kina-balu mountains.[4]

No details are available.[5]

SALT.

Our knowledge of the occurrence of salt in Borneo is still very defective.

The cause of this is to be found in the fact that no special search has been made for salt, its presence having for the most part, been only noticed by scientific travellers, mining engineers, and civil officers.

The particulars of the occurrence of salt are best known for West and South Borneo.

Little is known about it in East and North Borneo; this is again due to the fact that the former parts of the island have

[1] Everwyn W. 39, p. 66.
[2] Ib. W. 39, p. 65.
[3] Low N. I.
[4] Motley N. 7.
[5] St. John N. 9.

been subject to more investigations than the latter; that the geological structure of the island is, in all respects, better known in the west and south than in the east and north.

The presence of salt shows itself in the form of smaller or or larger salt marshes—known to the natives as *supang,* out of which a saline and often muddy water slowly issues.

Such brine springs are known in considerable number, and their wide distribution indicates a great extent of salt-bearing beds.

OCCURRENCE.

South Borneo.

In S. Borneo two such salt-marshes are mentioned by Grawbrowsky in the Dusson-Timor district; these are known to the natives by the names *Sopan tuën* and *Sopan tano.*[1] According to a communication I have received from the Consul Arnout, living in this neighbourhood, they are also known along the course of the rivers Montallat and Teweh. There are also numerous brine-springs in Central Borneo, along the rivers Lanung, Suku, and Bumban, in the District Siang-Murung. These are mentioned by Dr. Schwaner and Arnout. Schwaner writes of them:—"A remarkable phenomenon are the brine-springs which issue from the ground in many places in the highlands. The brine is evaporated by the natives for the preparation of their kitchen salt. The saline water issues from the joints of several varieties of rock at a depth of several feet beneath the surface."[2]

Brine-springs also occur in the remaining river basins. According to Dr. Schwaner, who has done so much toward the scientific investigation of Borneo, brine-springs occur in the drainage-areas of the Kahajan and the Katingan, traversed by him in his once renowned, now, however, almost forgotten travels. They occur along the river Sepang, a

[1] Indische Gids. 1884, Jan. p. 1 and Grawbowsky, p. 52.

[2] Schwaner S. 16, I. p. 24 and 127.

tributary on the left bank of the Menohing, a tributary of the Rungan, this itself being again the largest tributary of the river Kahajan; further along a small river of the same name, which flows into the river Katingan[1] on its left bank. Salt-marshes are not wanting in the western parts of S. Borneo; for instance, they occur along the river Pembuang, as was shown by Von Gaffron about the year 1840.[2] Taking together all the occurrences of brine-springs, known up to the present, we note their wide distribution, and their extension along the margin of the mountainous country, forming a bay-like opening toward the south. The scanty information respecting the occurrence of salt-marshes in the western drainage-areas only proves that these districts have been but slightly investigated, otherwise they would certainly have been found in as great number as they are, for instance, in the districts Siang-Murung and Dusson.

West Borneo.

Brine-springs are known to occur on the northern margin of the alpine mountain-land, separating S. from W. Borneo. They extend from the river Ambalauh to the river Skadau in an east-north-easterly and west-south-westerly direction, parallel to the mountain-chain running along the southern margin of the Kapuas basin, and eighteen to twenty kilometres south of the river Kapuas.[3]

According to Von Gaffron, salt occurs near the Santi stream, a tributary of the Tajan (upper basin of the river Melawi), near the Taiën stream, a tributary of the river Melawi, near the rivers Ella,[4] Serawi, and Amballan, the Spauk Karis stream, and in the upper drainage area of the Skadau.

---

[1] Ib. S. 16, II. p. 99 and 130.
[2] Von Gaffron S. 27.
[3] Von Gaffron, W. 29.
[4] Everwyn W. 39, p. 88 and Von Gaffron W. 29, S. 27

In the last-mentioned instance, the brine-spring occurs in an alluvial tract about two miles up the right bank of the Kenaja stream, which flows into the river Skadau, above the village Slalang. The saline water issues from a spring three metres deep, protected by wood-work. It is said to have a bitter taste, and is, on this account, seldom used for the preparation of salt.

Brine-springs are said to occur near Mantrap brook, a second tributary of the river Skadau, three days' journey from its mouth.[1]

Three brine-springs occur in a plain surrounded by low hills, near the river Spauk, three days' journey from its mouth.

When visited by Dr. Croockewit, the water slowly issuing from the spring, had a temperature of 81° F., when the temperature of the air was 82° F.[2]

The springs are thus most numerous between the rivers Skadau and Spauk.

Salt-marshes are also known near the river Serawai (tributary of the river Melawi), in the neighbourhood of the village Tumbang Tjerundung, and along the left tributary Sepan.[3]

East Borneo.

The only information available up to the present, is that salt is obtained in the highlands of Bulongan, in the land of the native race Kenjah.[4]

North Borneo.

According to a report of the natives, a brine-spring occurs at the foot of the Telong mountain (drainage area of the

---

[1] Everywyn W. 39, p. 35; Von Gaffron W. 26.
[2] Ib. W. 39, p. 35; Ib. W. 26.
[3] Schwaner S. 16, II. p. 175 and 176.
[4] Hageman E. 7.

Limbang).[1] It is fifteen inches in diameter, and springs to a height of three feet.[2]

A warm brine-spring also occurs in the neighbourhood of Kinoram (Sabah). It is warmer than the surrounding water.

Very little is known with regard to detailed geological relations, although there are facts that justify the conclusion that the salt-beds occur in the Tertiary-formation. They are probably of Miocene age, since Von Gaffron only mentions them as accompanying brown coal, but not in the strata containing black coal.

In the western parts of S. Borneo Von Gaffron mentions the wide-spread occurrence of gypsum in the Tertiary-formation. This mineral is probably of the same age as the rock-salt, as the two minerals are often associated in salt-bearing strata.

The rock-salt doubtless occurs also as "saliferous clay," which is indicated by the muddy saline water. Information as to the extent, thickness, and composition of the salt-bearing beds, is only to be obtained by deep borings; but there is little prospect of this being done, as it is not necessitated by any practical interests; and such researches will not be undertaken for the sake of pure science alone.[3]

These brine-springs were formerly used by the natives for the preparation of salt, and in places arrangements were made to collect the saline water.

Thus in the village Tumbang Tjerundung, in W. Borneo, a small shaft was sunk to the depth of six feet, when a clayey sandstone was reached, from the cracks of which the salt water issued. A hollow tree trunk was now inserted, and the pure brine collected in it. The preparation of kitchen-salt simply consisted in evaporating the brine in iron dishes. But the natives did not always prepare their own salt, as on the one hand, that purchased of the traders was

[1] St. John N. 9. [2] F. Hatton N. 48; J. Hatton N. 35.
[3] Von Gaffron S. 27; Martin B. 39, p. 334.

cheaper and purer; and on the other, they could earn more money in the same time by gold-digging.[1]

The manufacture of salt has at present, almost entirely ceased, as the natives procure cheap salt through the government. It is well known that the salt monopoly exists in the Dutch Indies.

Analysis have been made of the Spauk[2] (W. Borneo) occurrence.

The water is odourless, has a saline or bromide-like taste, and contains much carbonic acid.

SiO_2	0·005	5·756.
NaCl	4·308	
KCl	0·060	
$MgCl_2$	0·186	
$CaCl_2$	1·202	
MgI_2	0·004	
$MgCO_3$	0·001	0·058.
$CaCO_3$	0·053	
$FeCO_3$	0·004	
	5·828 solids.	

The water analysed by Veltman[3] has a yellow colour (due to the presence of organic substances), and a bitter taste.

The solid constituents amounted to 6·2 per cent., of which five per cent. was NaCl. There was further $MgCl_2$, $CaCl_2$ and $CaSO_4$.

ARSENIC.

Arsenic-ores are known only in Sarawak.

Metallic arsenic was found years ago near Bidi, in a vein accompaying antimony, but it was worked for a short time only on account of the small profit attainable. It occurs in

[1] Schwaner S. 16, II. p. 175 and 176.
[2] Jb. v/h. M. 1882, II. p. 102 ; Rost von Tonningen W. 27.
[3] Schwaner, v/h M. 1882, II., p. 102 ; Veltman W. 30.

two varieties: in curved laminated kidney-shaped masses, and in small granular scales. Realgar and auripigment also occur, but in small quantities. The former is found in somewhat greater abundance near Gading, and in the upper basin of the Rejang; in traces also on the R. Barram, and near Miri.

A vein of argentiferous arsenic ore (proustite, or ruby silver ore) occurs in Bidi. An attempt at working it proved unprofitable.[1]

Near Nanga Merau in W. Borneo, Van Schelle found cherry-red acicular crystals of realgar in a dyke of andesite traversing clay-slates.[2]

COBALT AND NICKEL.

The occurrence of these ores is still very questionable. According to older accounts nickle occurs throughout the whole of Sarawak, especially in the gold and tin (?) districts, associated with cobalt and iron.[3]

But this has not been confirmed, and no further details are available.

CORUNDUM.

It is mentioned in an old work that corundum, derived from Borneo, was imported into China, but no further details are available. It is more probable that this corundum consisted of diamonds from Landak and Sarawak.[4]

But it has already been mentioned that corundum is the faithful companion of the diamonds in the drifts.

MOLYBDENITE.

Specimens of this ore were sent to Batavia for examination in 1871. They were derived from Mount Ampar (district Landak, W. Borneo).

---

[1] Everett N. 23, p. 19, and Frenzel B. 38.
[2] Jb. v/h M. 1884, I. 143.
[3] Low, N. 1.
[4] Everett N. 23 p. 16

Again in the eighties, samples were obtained from Landak,[1] and also from the neighbouring Sarawak. The ore consisted of tabular crystals in stellar aggregates.[2]

No details are available with regard to the parent rock, occurrence, and distribution.[3]

MANGANESE.

Manganese-ore is at present only known to occur in one place in S. Borneo (G. Bessi), and in Sarawak.[4]

About two and a-half kilometres north-west of Pengaron, there is an isolated hill (Gunong bessi = iron hill) of about fifty metres height and 800 metres circumference. It lies near a dyke of augite-andesite, cutting late Tertiary sandstone strata, and is covered with a thick layer of earth and numerous boulders, of which many have a volume of forty to sixty cubic metres.

These boulders consist of a very hard steel-grey polianite (MnO_2) usually with a blackish deposit of wad on the surface.[5]

This occurrence was confirmed as early as 1858, and it was decided to collect fifteen pounds for chemical examination, but the insurrection which broke out in the following year prevented the execution of this plan.[6]

Verbeek considered this hill to be the highest part of a massive occurrence (stockwork), the whole hill consisting of ore; he calculated its volume to be 215·000 cubic metres = one-third of the hill, which could be worked from above.[7] A more detailed investigation carried out by Hooze (in 1883)

[1] Javaverslag 1884, II.

[2] N. 16 p. 501, 511.

[3] W. 53, and the same in Jb. v/h M. 1879, I., p. 89.

[4] Schwaner states that he found small quantities of psilomeolane in different localities of the former kingdom of Bandjermassin.

[5] *Java Courant*, Verslag v/h, Mynwezen 1883, 4th Kwartaal.

[6] C. de Groot, B. 22.

[7] Verbeek S. 41, p. 90.

showed, however, that these boulders were simply derived from a vein of about ten metres thickness, traversing a grey andesitic tuff, and having the same strike and dip as the coal-seams of Pengaron. According to Hooze it is a case of lateral secretion.

Chemical analysis showed that the amount of manganese in the ore is very variable. Different samples gave the following percentages:—0·20 per cent., 0·25 per cent., 0·56 per cent., 0·64 per cent., 54·40 per cent., 78·69 per cent. Ca, Ni, and Zn. were not found.[1]

According to an analysis made in Freiberg in Saxony, the manganese percentage is 97·27 per cent.

In Sarawak manganese ores are known in the districts Sarawak proper (Bidi), Lundu, and Rejang, but nowhere in workable quantity.[2]

ALUM.

Mentioned by Von Gaffron as occurring in the Telawi mountains, in the western parts of S. Borneo (Kottaringin).[3]

SALTPETRE.

Mentioned by Gallois as occurring in the state Bulongan.[4]

PETROLEUM.

The same may be said about the presence of petroleum in Borneo as about the occurrence of salt. At present mineral tar (bitumen) or petroleum-springs, are known to occur in few places only. Their composition is given by some analyses.

It is, however, already evident that, as far as we know at present, every petroleum locality occurs in the coal-bearing Tertiary Strata.

---

[1] Jb. v/h. M. 1884, II. 325.
[2] Everett N. 23, p. 20.
[3] Von Gaffron S. 27.
[4] Gallois E. 9.

OCCURRENCE.

South Borneo.

A petroleum-spring occurs in Martapura (district Riam Kiwa), at the foot of Pakken mountains, near Rantan Budjur. It is in the sandstone beds of the Eocene, and yields a litre per day.[1]

A little further to the north between Lampeon and Pringin (division Amunthai, District Alay and Bulongan) there is a spring yielding three litres a-day in dry weather, the amount diminishing in the rainy season. The oil is dark-brown, thick, and tarry. It does not possess any great proportion of carbohydrats, and could only be used for the manufacture of gas.[2]

Down stream from Tandjong, near Poin, (?) there is a petroleum-spring which gushes up from the ground like a river. It is liquid in the middle, but hard as pitch at the edges.[3]

West Borneo.

At present nothing known respecting the occurrence of petroleum.

East Borneo.

A petroleum-spring occurs in the kingdom of Kutei, not far from the mouth of the Mahahkam stream.

It is by the little tributary Sanga-sanga, and 1,500 metres from the mouth of the Minjak Tanah. The basin, situated at the bottom of a line of hills, is about 1,000 metres wide, and covered with a crust of asphalt; 500 metres to the south-west, in the hills, is an enormous eruption of burning gas. The brownish, viscid mass, becomes fluid when heated to 100° C. giving off water-vapours. At a higher temperature non-combustible gases are given off at first, while there

[1] Verbeek S. 41, p. 114. [2] Bernelot-Moens S. 37. [3] Hartman S. 34.

remains behind a beautiful thick tar, suitable for the manufacture of vaseline or asphalt.[1]

Engineer Menten found, in 1863, some petroleum springs on the island of Tarakkan, near the mouth of the river Sibawang. They appear, however, to be of small dimensions.[2]

North Borneo.

In Sarawak, petroleum has been found in the Sadong district.[3]

On the island of Labuan there are some pretroleum springs. They occur in places 400 to 500 yards below the coal-seams, between blue slates of apparently great thickness. The oil is dark-coloured but fairly pure.[4]

Petroleum was found by Witti[5] in the territory of the British North Borneo Company, on the river Seknati. This occurrence has been investigated by F. Hatton.[6] Not far from the coast is a swampy piece of ground, the clayey soil of which is, for an area of about eighty yards in circumference, soaked with petroleum. At high water, everything is flooded. A shaft of thirty-five feet was sunk. Under a bed of clay, four feet in thickness, is a ferruginous sandstone, interbedded with shales, from which the petroleum is derived. As in Labuan, pieces of coal with resinous parts were also found. The petroleum is a thick oil or bitumen: the distilled oil is composed of:—

Carbon, ...	82	per cent.
Hydrogen, ...	10	„
Oxygen, ...	8	„
	100	„

[1] Jb. v/h. M. II. 1885, 139, and 1886 I.; 1883 and Javaverslag 1886 I.
[2] De Gréve B. 24.
[3] Everett N. 23.
[4] Motley N. 7
[5] Witti E. 42.
[6] Fr. Hatton N. 48; J. Hatton N. 35.

It consists of two substances: petroleum or paraffin oil, and an oxydisable body belonging to the camphors or turpentines. With the oil is associated a colourless odourless, and non-explosive gas.

WARM SPRINGS.

Warm springs occur in several places in Borneo.

Thus warm and sulphur springs are known in S. Borneo, according to Grabowsky, at the foot of the limestone caves Batu laki and Batu bini (district Amandit),[1] and similarly Hartmann mentions the occurrence of a bluish water, smelling strongly of sulphur, between Tandjong and Tabalong.[2]

In W. Borneo warm springs occur on the rivers Blintang and Katingan (tributaries of the Kapuas); one of them contains sulphuretted hydrogen, and has a high temperature.[3] Similarly the natives report the occurrence on the Skabat brook, a tributary of the Katungan, of a spring of such warmth, that eggs can be boiled hard in it.[4]

There are also more warm springs in the neighbourhood of the Bajang mountains, in the basin of the Upper Sambas. On analysis one of these gives the following result:—[5]

SiO_2	0·067 grms.
Cl	0·047
Ca	0·034
CO_2	0·025
Soda	0·055
	0·228
In combination:—	
SiO_2	0·067
$CaCo_3$	0·054
NaCl	0·077
	0·198

[1] Indian Gids 1884, Jan. p. 1.

[2] F. S. Hartmann S. 34.

[3] Everwyn W. 39, p. 12, and Von Gaffron W. 29.

[4] Ib. W. 39, p. 27.

[5] Jb. v/h. M. in N. J. 1885 II. p. 115.

Residue per litre,	...	...	0·207 grms.
Loss on ignition,	...	...	0·007
Salts,	...	...	0·200

Warm springs are also known in Sarawak—namely, in the upper course of the R. Lingga, also near Babang near the boundary with Sambas.[1] The following is an analysis of the latter spring:—[2]

SiO_2	...	...	0·020 grms.
Cl	...	...	0·021
CO_2	...	...	0·109
Ca	...	...	0·090
Mg	...	...	0·034
Soda	...	...	0·031
			0·305

In combination:—

NaCl	...	...	0·035
$Ca\ Co_3$	...	...	0·160
$Mg\ CO_3$	...	...	0·071
$Na\ SiO_3$	...	...	0·032
			0·298
Residue per litre,	...	...	0·300
Loss on ignition,		...	0·027
Salts,	...	...	0·273

F. Hatton found a warm saline spring near Pinowanter in the Kinoram district (Sabah).[3]

[1] Everett N. 24. [2] Jb. v/h M. in N. J. 1886 I. p. 183.
[3] Hatton N. 48, p. 238.

IV.—MINING OPERATIONS.

The mining operations in Dutch Borneo can be divided into three periods similar to those into which we have divided the geological investigations.

The first period extends to the first half of the nineteenth century; the second embraces the fifties,—*i.e.*, the period in which the Indian mining-engineers began to make their influence felt; the third period falls in the eighties,—*i.e.*, the second period of activity among the Indian mining-engineers in Dutch Borneo.

FIRST PERIOD.

It is not known whether the Portuguese and Spaniards, who visited the Indian Archipelago in the beginning of the sixteenth century, busied themselves with mining pursuits; but it is not improbable that they traded in gold and diamonds.[1]

The Dutch, who came to India at the end of the sixteenth century, also confined themselves at first to the trade in gold and diamonds. This trade was exceedingly profitable to the East Indian Company in W. Borneo, even in the first half of the eighteenth century.

When the colonies came under the direct rule of the Dutch, and in 1816, after a short period of English rule, came again into the possession of the Netherlands, the Indian government directed its energies especially to W. Borneo.

In 1823 a contract was made with the Prince of Landak, by which the diamond mines were placed in the hands of the

[1] Veth W. 17, cat. tentoonst Amsterdam 1883 III. p. 185.

Indian government in consideration of an annual subsidy. No great profits appear to have accrued from the bargain, for in 1827 the contract came to an end. In 1831 a similar attempt was made, but again without success, for the monopoly came to an end in 1833. In 1823 the Indian government also attempted to work a gold mine in Madjau, on the R. Blintiang, in W. Borneo, by making advances to the workers, but this attempt lasted only a short time, as it also proved unprofitable.

These were the only mining operations of this period.

SECOND PERIOD.

The year 1850 brought a great revolution in mining matters to the East Indies. Up to that time the government monopoly system prevented private individuals from promoting such undertakings; and, on the other hand, the mining knowledge of the Europeans living in the East Indies was too circumscribed to permit them to go deeply into operations of this nature.

A change took place in both directions. The monopoly system was brought to an end; in its place liberal regulations were made by which private individuals were also permitted to take part in mining operations. In the year 1850, the corps of Indian mining-engineers was called into existence, the task of which was to search for useful minerals, and these being found, to work them.

It thus came about that in the beginning of the fifties, the mining-engineers C. de Groot and Rant in South-east Borneo were carrying on investigations in search of coal, while Everwyn prospected for coal and other useful minerals in W. Borneo.

PRIVATE ENTERPRISE.

The Coal Mine "Julia Hermina," near Kalangan.

This mine, situated in the neighbourhood of the Kampong

Banju-irang, ten miles to the south-west of Martapura, takes the first rank in S. Borneo. After Rant had proved in 1853 the outcrop of coal in three places in Tanah-Laut, a private individual (R. J. W. P. Wynmalen) sought to obtain a concession to work coal in Tanah-Laut. This concession (called "Concession of Banju-irang," after the chief place), was granted him in 1854.[1] The district to be worked extended from the sea-coast to beyond Martapura, and the northern and southern boundaries were formed by the rivers Martapura and Tabanio. The concession which extended over a period of forty years, and granted exclusive rights to work coal in the district mentioned, in consideration of a subsidy of one-fifteenth of every ton of coal, soon passed into other hands—a private company in connection with the "matschappy tot bevordering van mynontginningen in Nederlandsch-Indie." This company named the coal mine the "Julia-Hermina."

By 1857 the preliminary works were for the great part finished. The shaft had a depth of 21·0 metres—at a depth of sixty metres they hoped to reach the seam—the ventilating shaft was twelve metres deep; the level fifty metres long. The railway which was to connect the mine with the coast was also half finished.[2]

After 1857 they commenced the erection of the water-conduit, and the dwelling-houses for agent, engineer, assistant-engineer, foreman of the works, book-keeper, cashier, and doctor. The number of the workers amounted to 370.

In 1859 the preliminary works being completed, they commenced to work the coal, and had raised 2,000 tons,[3] when the insurrection broke out, in which the whole staff was murdered, and the works completely destroyed.[4]

---

[1] C. de Groot S. 23, p. 48.

[2] T. v. N. J. 1857, II. p. 324.

[3] The coal was raised by steam power.

[4] C. de Groot B. 22. The director of the mine, J. Motley, an Englishman, formerly of Labuan, was also killed (Bleekrode B. 16).

Since this time the mine has been abandoned. It is true that eighteen years later (1874) the proprietors of this mine entertained the plan of starting it again, and the former concessions were also granted them for another period of forty years, but only in respect of the mine "Julia-Hermina." But a few years later they abandoned the design.[1]

Other Undertakings.

It was still worse with the remaining undertakings. They never got beyond the preliminary stage.

Thus, in the fifties, a company had the intention of working the iron-ores in Tanah-Laut, which had been discovered by Von Gaffron, and examined by Rant in 1854. But nothing came of the plan. Engineer Everwyn, who happened at that time to be carrying on investigations in W. Borneo, undertook to prospect for copper in the neighbourhood of Mandhor. The investigations, however, led to no favourable result; for, although numerous localities for copper-ore were found, the amount was too small to repay working. In consequence, the idea of working ores there was again given up in 1861.[2]

Again, on the east coast, in Kutei (in Pelarang), a private capitalist, by name King, one of whose ships had discovered coal there, undertook, in 1848, to supply coal at twenty-four florins per kojan; but he soon withdrew from the contract.[3]

We thus see that private undertakings were not successful. It was otherwise with government operations.

GOVERNMENT ENTERPRISE.

As early as the beginning of the fifties, the government thought of opening coal-mines with the intention of supply-

[1] Jb. v/h. M. 1878, II. 231, and Ib. 1880, II. 73.
[2] C. de Groot, B. 22.
[3] Jb. v/h. M. 1874, II. 79.

ing the Indian Navy with good and cheap coal, and thus to dispense with the English coal hitherto used; but especially to be able to supply their want in the case of war from their own resources.[1]

Four government coal-mines existed in S. Borneo—the coal-mine "de hoop" (Hope), on the R. riam Kiwa (1846–1848); the coal-mine "Oranje-Nassau," on the same river, near Pengaron (1848–1884); the coal-mine "Assahan" (1872–1881); the mine "Delft," on the river Kanan, which, however, never came to be worked, and in E. Borneo, the coal-mine "Pelarang" in Kutei (1861–1868).

Of all these operations only the mine near Pengaron enjoyed a longer existence, the others were more or less unimportant.

In W. Borneo also the government had the attention in the fifties of opening a coal-mine near Salimbau, but it was abandoned when the prince of this state personally undertook to supply coal to the Navy.[1]

Coal-mine "de hoop" (= Hope).

When Schwaner discovered the first coal-seam, in 1844, on the river riam Kiwa, the coal was at once tested, and as it appeared to be suitable in part for smithy, in part for boiler fuel, a coal-mine (the first in India) was opened near Lokpinong (= Lokbesaar) in 1846.[2]

A shaft was first sunk; but before it could be used it fell in, in consequence of its unsuitable position and bad timbering. As it soon became apparent that the place was not suitable for a coal-mine, the numerous shallows and rapids in the river being unfavourable to the construction of a water-

[1] C. de Groot, B. 22.

[2] C. de Groot S. 23. According to Schwaner S. 21, in the year 1845, and also in Tydschrift voor, N. I. 1887, January, p. 34, 1845, at Murai, on the riam Kiri (= Kiwa) river.

conduit, and the distance from Bandjermassin being too great (116 km. = 77 pal.), it was decided, after the lapse of two years, in 1848, to abandon the mine, and the miners moved twenty-four kilometers down stream to Pengaron. The production during these two years amounted to 500,000 Amsterdam lbs. of coal.[1]

The Coal-mine "Oranje-Nassau" in Pengaron.

As already mentioned the miners who, in August, 1848, abandoned the coal-mine near Lokpinong, settled near Pengaron, so-named after the hill-range (twenty metres high), which follows for some distance the course of the river.[2] In 1849 the first level was opened in the presence of the Governor-General of the Dutch Indies, and under the able supervision of Von Gaffron, the first administrator of the mine whose perseverance and industry it was that enabled them to overcome the initial difficulties. The mine received the name "Oranje-Nassau.[3]

The distance from Bandjermassin, the centre of the coal industry, is 92 kilom. (= 61 pal), and from the mouth of the Barito is 104 kilom.

At the commencement three Belgian miners were set to work in different spots in the hill-range. The purpose of this division was to see which method of mining was the best.

The consequence was that each was eager to furnish the greatest amount of coal. No union existed between the three mines, and no provision was made for the future.

Between the years 1848–1872 the mine was worked by levels, the coal being worked down to the foot of the hills.

---

[1] Schwaner S. 21.

[2] Schwaner calls it the Gunong Batu bobaris: the water-shed between the rivers Riam Kiwa and Kanan.

[3] Two years earlier coal had been worked here, and 1,106 tons were raised. (Jb. v/h. M. 1874, II.)

Every time a hill was worked out (every third or fourth year) the position of the mine had to be changed, necessitating the construction of new works, roads, etc. As early as 1868, the fact was recognised that, at no very distant date, the coal would be completely worked out, and it was determined to proceed to deep mining.[1]

At this time the direct management of the mine was entrusted to a mining-engineer who was stationed in Pengaron itself; whereas before this time its supervision had been the duty of the Resident in Bandjermassin, the highest civil official in S.E. Borneo; and all disputes between the real director of the mine ("captain" = *opziener by het mynwezen*) and the administrator had to be settled by him. The direct control was now placed in the hands of the mining "captain," and the technical control in those of the mining-engineer in Bandjermassin.

The second period extended from 1872 to 1884, and is characterized by deep mining operations. In 1872 the preliminary work was begun. Two shafts were to be constructed—one for raising the coal, the other for ventilation. These were to be not more than seventy-five metres deep, as the Indian Government did not wish to extend the mine too much. But seven years elapsed (till nearly the end of 1878) before the shaft was in working order. At the end of 1872 the working shaft had reached a depth of 26·5 metres; in the following year little could be done for want of timber. In 1874 the depth was sixty-three metres, and in the early months of 1875 a depth of eighty metres had been reached. The other shaft progressed at a somewhat slower rate. In the first year it had reached a depth of 29·0 metres. During the next two years the work had to be stopped, on account of water having broken in; and it was only in 1876 that the required depth of seventy-four metres was reached.

[1] Between 1853 and 1859 a small shaft was sunk to a depth of 19·0 metres, but the work was abandoned in 1859 (Jb. v/h. M. 1874, II., p. 104.)

At a depth of twenty-five metres a cross-cut was constructed, and a second at a depth of seventy-five metres. These cross-cuts traversed the coal seams and united the two shafts.

The long period over which these preliminary works extended were caused by a variety of circumstances and difficulties unknown in Europe. At first there were no skilled workmen; then they had to contend against water. A great number of the workmen became ill; the necessary wood for timbering failed, and had to be fetched from Java, although Borneo has a superabundance of all kinds of timber. Besides these difficulties there was the delay caused by the necessity of having to obtain consent from Batavia for every innovation. This often requiring months to accomplish.

It was not till 1880 that the deep workings were begun. The first task was to drive the three levels (in seam C) for a distance of 750 metres in a N.E. direction,[1] this length being reached in 1881. By this preliminary work three long coal pillars were prepared for working, so that at any time the annual production could be raised to 25,000 tons, and the price of coal considerably reduced. But in 1881 the Indian Government determined to make the working of this mine dependent on the results of the prospecting investigations in search of coal in the state Berau on the East Coast. In consequence of this the production had to be reduced to meet the requirements of the market.

A series of calamities was the cause of this determination on the part of the Indian Government. The cost of production of the Pengaron coal was always high and its quality poor, so that it could not compete with English coal. Consequently the sale was always small, and the mine was worked at an annual deficit of 100,000 florins.

A ton of coal *loco* Pengaron was calculated in 1882 at five florins, with a production of 24,000 tons. With a production

[1] During this time the necessary coal was furnished by the Mine Assahan (q.v.)

of 12,000 tons at seven florins,[1] the transport on the riam Kiwa to Bandjermassin at 3·50 to 3·60 florins, so that the coal *loco* Bandjermassin cost 10·50 to 10·60 florins.[2] Thence to Java the conveyance cost 6·20 to 6·75 florins[3] per ton, so that in the Java harbour the coal was sold at 17 to 17·25 florins per ton, while the superior English could be bought there for nineteen to twenty-two florins. The price of Pengaron coal of inferior quality was thus too high to permit of any considerable sale. The Indian navy gave it a trial, but complained that it flamed too much, gave too much ash, and injured the boilers by the production of inflammable gases. Similarly the sale among private individuals was small, and only a small amount of smithy coal was disposed of.

In 1882, attempts were renewed to bring the coal into general use in the navy, the harbour works of Batavia, and on the state railroads. That the navy was strongly opposed to its use has already been mentioned.[4] In the harbour

---

[1] For every ton of coal raised 0·50 florins had to be paid to the proprietor of the land.

[2] According to C. de Groot, the price per ton, *loco* Pengaron, was, in the fifties, 9·50 florins ; to transport to Bandjermassin five florins ; *loco* Bandjermassin, 14·50 florins. (See Jb. v/h. M. 1874, p. 31.) But in another place he says the coal cost 10·54 florins, *loco* Bandjermassin, between 1848 and 1859.

[3] This was subject to small annual fluctuations.

[4] The Pengaron coal was also tried for gas-making, and Dr. Crétier, chemist to the Indian Mining Establishment reported favourably upon it, but no practical results followed. The analyses were as follows :—

	C.	H.	N. + O.	Ash p. c.	S. p. c.	Coke p. c.
Seam C	69·5	5·25	13·43	6·5	0·04	52·4
„ D	67·5	5·06	16·74	5·6	1·74	51·4
„ E	67·7	6·21	16·64	4·2	1·50	52·4

(See Dr. Crétier s. 43.)

In 1882 the following amounts were exported from Bandjermassin :—10,000 tons for the state railroads ; 2,000 tons for the navy; 1,500 tons for the harbour works. In 1884 4,000 tons were exported.

works and state railroads, on the other hand, the coal was found serviceable; but its price per ton was fixed by the state railroads at fifteen florins, as it was calculated that its effective value was 27·8 per cent. less than that of English coal (nineteen florins per ton).

The harbour works in Batavia, however, agreed to pay sixteen florins per ton; but as the price of the coal, *loco* Java, amounted to seventeen florins, there would have been a loss of one to two florins.

The failure of these last attempts to find a larger market hastened the determination of the Indian government to abandon the mine. In July, 1884, a fire took place, which, however, caused no great damage. On the 18th October, 1884, the mine stopped working; but it continued to be kept in good order, in view of the possibility of disposing of it to a private company.

In this way the mine "Oranje-Nassau" in Pengaron opened with so many hopes, came to an end, after a precarious existence of thirty-six years.

The production during these thirty-six years was not large. From 1848 to 1870 (inclusive), the time of the adit workings, it amounted to about 150,000 tons;[1] from 1871 to 1884, the time of the deep workings, it amounted to 40,702 tons; the total, between 1848 to 1884, being 194,702 tons of coal, and 11,207 tons of smalls (slack).

If we add to this the production of Assahan[2] (the auxiliary

---

[1] Verbeek S. 41, p. 114; Jb. v/h. M. 1874, II.

[2] Up to 1884 the slack, about 40 per cent. of the whole produce, remained unutilized. The mining-engineer, Hooze, attempted to bring this also into use, and had some sent to Holland for the experimental manufacture of *briquettes*. As the experiment was successful, their manufacture was projected in Java; but the enterprise was wrecked by the costly transport. Then the attempt was made to press the slack into cakes at a high temperature without the admixture of foreign material; but the abandonment of the mine prevented the execution of this idea.

mine of Pengaron) =47,168 tons of coal and 6,361 tons of slack, the total production for the two mines amounts to 241,770 tons of coal and 17,568 tons of slack.

The annual production in tons (in Pengaron) is given in the following table :—

Year.	Coal in Tons.	Slack in Tons.	Exported to Band-jermassin.	Left at the Mine.
1848 and 1849[1]	1,281[3]		1,281	?
1850	2,113		2,113	?
1851	5,774		5,774	?
1852	7,341		7,341	?
1853	9,768		9,768	?
1854	14,794		14,794	?
1855	14,524		14,524	4,323
1856	13,325		17,438	210
1857	11,228		6,455	4,983
1858	12,908		?	?
1859	5,857		5,194	?
1860	617		556	140
1861	1,839		1,879	100
1862	2,476		2,055	521
1863	1,962		2,483	0
1864	5,862		3,680	2,142
1865	4,572		4,933	1,781
1866	6,200		5,220	2,761
1867	3,936		6,697	0
1868	2,490		1,558	932
1869	10,000		5,700	5,232
1870	9,817		9,458	5,564
1871	4,538		7,354	2,343
1872	5,811		7,099	1,055
1873	7,350		5,870	2,535
1874[2]	—		—	—
1875	—		—	—
1876	—		—	—
1877	—		—	—
1878	594		—	—
1879	1,301		—	—
1880	3,658	2,184	7,816[4]	4,596 } 6,283 slack.
1881	1,838	410	—	2,251 }
1882	4,637	2,087	—	979 11,034 ,,
1883	6,457	3,174	6,598	437 13,970 ,,
1884	7,781	3,352	7,885	14 10,618 ,,

[1] Between 1846 and 1848 1,106 tons were raised (Schwaner S. 21.)

[2] During the years 1874 and 1878 the shafts were being sunk, and no coal was raised. Assahan furnished the supplies during this period.

[3] At least so much must have been produced, as the export amounted to these figures.

[4] From the two mines together.

This table shows that the most flourishing period of the coal mine "Oranje-Nassau" falls in the earliest part of its existence. Between the years 1853 and 1858 over 10,000 tons of coal were raised annually, the production reaching 14,794 tons in the year 1854. The insurrection in S. Borneo, lasting from 1859 to 1863, was a severe blow to the mine, the production sinking to a very low level. In the year 1859 the work was stopped for two months, as rebels appeared in the neighbourhood of the mine. Later on the convict labourers had to serve on military expeditions, by which the strongest hands were removed from the mine, so that in 1862 their number decreased to 100 men, while in former years it had been 400. In consequence of this deficiency some of the levels had to be abandoned. They then fell in, and much labour and money had to be expended in their subsequent reconstruction.

When peace was restored in 1864, the work was begun with renewed vigour. The number of the miners was slowly increased, so that in 1868 it once more reached its former strength of 400 men. Similarly the production was slowly increased, even reaching, in 1869, 10,000 tons. But a greater amount could not be raised on account of the small sale, which still remained less than the out-put. Thus in 1869, only half of the coal produced was carried to Bandjermassin, and in 1870, in spite of a diminished production, a still greater quantity remained in Pengaron. The insufficient means of transport by water prevented the development of the production. During about two months of the year, the transport had to be stopped on account of the lowness of the water, and, on the other hand, much difficulty was experienced in getting sailors and boats. The lack of sailors was (*e.g.* in 1877) so great, that some of the convicts had to be removed from the mine for this purpose, of course to the detriment of the production.

In 1871 a fire took place, by which 405 tons of coal were lost. Between 1874 and 1878 there was no out-put in consequence of the construction of shafts for deep-working.[1]

Mining Details.

The coal-seams at Pengaron strike south-west and north-east, and dip from 35° to 50° to the north-west. Of the nineteen beds, however, only six were worked at a profit: namely, seam A = 1·50 metres in thickness; seam B = 0·63 metres; seam C = 2·40 metres; seam D = 1·20 metres; seam E = 0·55 metres; seam F = 1·30 metres.[2]

The whole complex of the strata is well exposed in level No. 1.[3] The total thickness of the coal-seams amounts to 10·66 metres.

Immediately on the opening of the mine, the Pengaron coal was tried in various steamships, and the opinions expressed on its value were very different. This was occasioned by the fact that the samples were taken indiscriminately from all the seams. When the seams were separately examined (*e.g.* on board the "Vesuvius") it appeared that seams A, C, D, were good coal for boiler-fuel, and that seam F was a good smithy coal. Consequently, it was decided to work seams A, C, D and E, and to reserve seam F for necessitous use. But seams F and E were abandoned as early as 1852, on account of their small thickness and poor quality. In later years, during the deep-working, seam C alone was worked, as seams D and F proved to be of such variable thickness as to be worthless, while seam A crumbled to small coal. During the working it was seen that the relations of the seams did not remain the same as they were at the beginning, or in level No. 1.

---

[1] C. de Groot B. 26, S. 23; P. H. Renaud S. 39, and Verslagen v/h M. in the Jaarboeks.

[2] According to de Groot's calculations seam A produced 500 kilos. per cubic metre; C = 650 kilos.; E = 800 kilos.; F = 400 kilos.

[3] See Level No. 1 under "Occurrence of Coal."

The intervening material especially was found to thin out from west to east. Thus, for instance, between seams C and D, in level No. 1, the intervening material is 1·18 metres thick; in the eastern hill-range Kembang Kuning, the two seams almost touch one another, while further to the west (Muara-Ilik), the intervening material amounts to nine metres.

The angle of dip also changes, and the beds were observed dipping at an angle as high as 80°. On the other hand, the thickness of the coal-seams is subject to no great variations and no faults of any importance occur.

At a depth of seventy-four metres, the thickness of the seams has considerably diminished: seam A has decreased by 0·23 metre; B by 0·11 metre; C by 0·20 metre. The quality of the coal in seam F changes but little; but that of seam A is crushed and crumbled. The total thickness at that depth was 4·47 metres.

Seam A	=	1·73	metres.
„ B	=	0·52	„
„ C	=	2·22	„
		4·47	metres.[1]

In the coal mine Oranje-Nassau, in Pengaron, there are two shafts, one a vertical hauling-shaft eighty-one metres deep, and the other a ventilating-shaft following the dip of the seams.

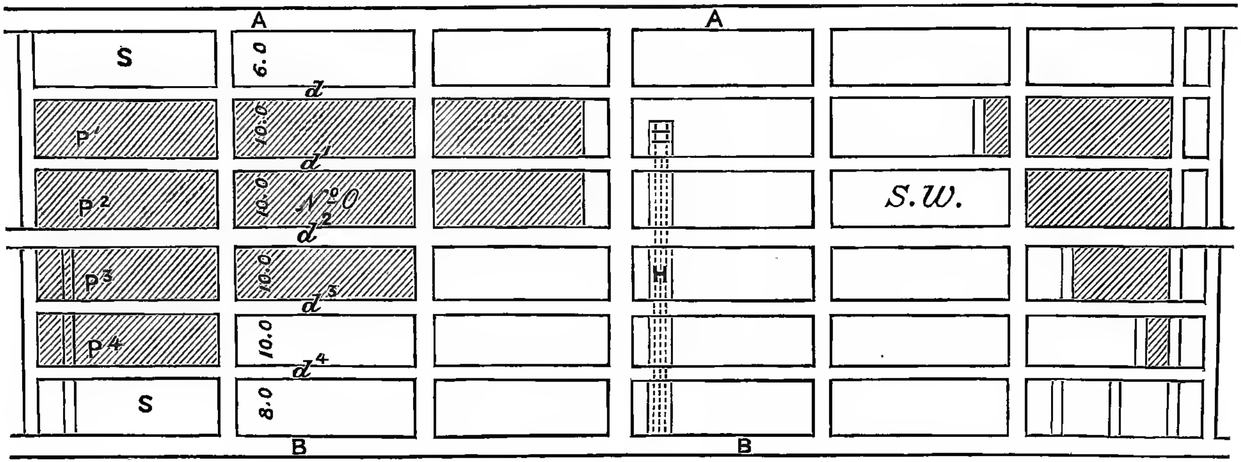
These shafts are united at a depth of seventy-four metres by a level crossing the seams (bottom-level), and again at a depth of twenty-five metres by a cross-cut (ventilating level).

The depth of the mine, reckoned to the level of bottom-level, is seventy-four metres.

[1] H. v/h. M. 1879, II. p. 199.

THE ORANJE-NASSAU COAL-MINE IN PENGARON.

Plan of Workings.



A = Ventilating level.	d^2 = drift No. 2, middle level.	P^1 = Worked off pillar No. 1.
B = Bottom level.	d^3 = drift No. 3.	P^2 = ,, ,, ,, 2.
d = drift No. 0.	d^4 = drift No. 4.	P^3 = ,, ,, ,, 3.
d^1 = drift No. 1.	S = Safety pillars.	P^4 = ,, ,, ,, 4.

H = Hauling incline with balance weight.

The machines used in the mines were:—

One hoisting machine,	...	20 horse-power.
One ventilator (Guibal's),	...	5 „
One chain-pump (Bartier's),	...	20 „
One steam-pump (on the bottom-level),		22 „
Total,		67 horse-power.

It is calculated that in ten hours 120 tons of coal could be raised, and in twelve hours 1,000 cubic metres of water.

In the seam C the bottom, middle, and ventilating levels have been driven 700 metres long in a north-easterly direction from the hauling-shaft; towards the south-west the bottom and ventilating levels only extend for a few metres.

These levels, which are driven along the strike of the seams, are connected at intervals of 35·0 metres by so-called chimneys ("Schornsteine").

In the later years the method of working was "pillar-work."

In chimney No. 18, 550 metres from the shaft, a passage has been broken, and is used as a "jinny-road" to convey the coal from the pillars on both sides of the road between chimneys Nos. 15 and 21. The seam here has a dip of about 50° toward the north-west.

The coal is worked in steps towards the "jinny-road."

Working-staff and Arrangements.

Since 1868 the coal mine of Pengaron was under the direction of a mining-engineer. He was assisted by four master miners (opziener by het mynwezen), and two machinists.

The remainder of the staff consisted of[1] an administrator, who conducted the management of the mine, a clerk, a chief of the hospital and the kitchen, a jailer, and convict-overseer.

[1] Among them there were, in 1873, sixteen to twenty per cent. cases of illness; but only seven per cent. in 1884. Latterly the number of prisoners has averaged 200. In 1884 there were about 309 men; these were distributed as follows:—forty-nine for the coal-transport, twenty-two for various services, six per cent. on the sick list, and 232 for the working—(Jb. 1886, II. 185).

Twelve native overseers (mander) looked after the miners, who consisted of 200 to 400 convicts.

The more skilful among them, who at the same time were well behaved, were promoted to be overseers in the mine, carpenters, masons, nurses in the hospital, and to be overseers in the coal depôts. About seventy-five per cent. remained for the mining operations proper. These gave much trouble. When they first arrived from Pengaron they had no idea of the work they had to do, and had to be taught, which in most cases required much time. That in spite of this no accidents took place must be ascribed to the zeal of the European directors. Other assistance was not to be had, as the "free natives" would not voluntarily join in the work.

The daily working-time consisted of eight hours, and was divided into three shifts—namely, from six o'clock in the morning to two o'clock in the afternoon; from two to eight in the evening, and from eight in the evening till six in the morning. For those who worked in the day the working-time was nine hours—namely, from six to eleven in the morning, and from one to five in the afternoon.

The daily earnings of the convicts were two per cent. per day, besides one to twelve and a half per cent. for extra difficut work (or as a premium for good behaviour), and thirty per cent. for every Sunday, the work being carried on on this day.

Those convicts who showed good behaviour during a certain time, were permitted to settle down in a village of their own near the mine. In time a pretty village of some size came into existence, in which each convict had his own home, built by himself. In his leisure time he was permitted to cultivate a rice field, and when married, could serve his time surrounded by his family under relatively favourable circumstances.

The sailors (natives) who conveyed the coal on the river were free men, who bound themselves over to this work for a space of three to five years, for a sum of twelve florins, and five florins a month and free board.

In the beginning of 1884 there were 111 free natives in the service. For the protection of the mine a small detachment of military, under the command of a lieutenant, was stationed in Pengaron; further, there was a military doctor, also a mine-doctor, and the "Controlleur" also had his residence there.

The Coal-mine Assahan.

1872–1881.

The coal-mine Assahan is also situated on the R. riam Kiwa, seventeen kilometres down the river from Pengaron.

Coal had been discovered here by the "Natural History Commission" in the beginning of the forties, but it had been forgotten. It was re-discovered[1] by the master-miner, Fleury, in 1852, and also visited by C. de Groot.

It was not till the year 1870, however, that the mine began to be worked—namely, during the time that the preliminary works for the deep mining in Pengaron were in course of construction, and the necessary coal had to be obtained from Assahan.

Only a seam of 2·50 metres thickness was worked, and this by means of a level. In the first years only so much coal was raised as was required for the works; and it was not till 1872 that the mine was regularly worked. But the production could never reach any very considerable height, owing to the defective means of conveyance.

In 1881 the mine stopped working, as it had been decided to abandon Pengaron. It was left in good condition, so that it could be re-opened at any later period.

The management of the mine was conducted by a mining-

---

[1] This locality is given on the coal-map made by the Natural History Commission of the country west of Muray, as far as Martapura (C. de Groot S. 23).

captain, with 100 to 150 convicts, while a small military detachment, under the command of a sergeant, kept the peace.

The total production during the nine years was 47,168 tons of coal and 63·60 tons of slack. The annual production varied from 3–7,000 tons.

Year.	Tons Coal.	Conveyed to Bandjermassin.
1872	7,099	7,099
1873	6,000	5,870
1874	3,637·5	4095·5
1875	3,830	3,814
1876	4,314	4,408
1877	3,208	3,172
1878	4,100	4,100
1879	4,916	3,399[1]
1880	7,007	and 4,110 tons slack
1881	3,507	2,250 "

Year.	No. of miners.
1879	140
1880	121
1881	94

The mine Assahan was opened to assist the Pengaron mine, and it was stopped when the latter was abandoned.

The Coal-mine "Delft."[2]

Just as the abandonment of the coal-mine "De-hoop" was the cause of the establishment of the coal-mine in Pengaron, so the mine "Delft" was to replace the abandoned mine "Oranje-Nassau."

Already, in 1852, C. de Groot, the chief of the mining staff in India, had recognized that Pengaron was not a favourable place for a coal mine, for the same reasons which had been

[1] 1880-81 lumped with Pengaron.

[2] C. de Groot B. 22; P. van Dyk S. 45; Ib. S. 47.

the cause of the abandonment of the first mine "De-hoop,"—namely, the great distance from the sea (140 kilometres), and the shallows and rapids in the riam Kiwa.

In the beginning of the fifties it was decided to gradually abandon the mine near Pengaron, and engineer Rant was commissioned to look for more favourably situated coal-seams in Tanah Laut. Among the localities discovered the coal-seams in the hill-ranges Djabok and Djalamadi, in the neighbourhood of Karang intan, on the riam Kanan, were the most favourably situated. The distance from Bandjermassin is only fifty-one kilometres, or about half as far as Pengaron, and as, according to C. de Groot's calculations, G. Djalamadi could furnish 36,000 tons of coal annually for eighty years, and the coal was found suitable for boiler-heating, it was determined to open a coal-mine here ("Delft"). Rant was instructed to make trial-borings in G. Djalamadi, to determine the value of the coal-seams[1] But in 1859 the insurrection broke out, and the boring-staff, with the exception of Rant, who was fortunately absent, were murdered, and the works destroyed.

This put an end to the idea of exchanging Pengaron with the more favourably situated mine "Delft," and for many years the mine was completely forgotten.

After twenty years the plan was again taken up, it being recognized that the coal-mine in Pengaron would never be brought into a flourishing condition. It was consequently decided to continue the boring investigations near Karang-intan.

It was calculated that the production would be cheaper here than in Pengaron, and that the water carriage would be halved. The coal could, it was said, be furnished at 3·35 florins lower rate than in Pengaron. But adverse opinions were also promulgated. Engineer Menten, who conducted the

[1] For stratigraphical details, see under "Occurrence of Coal."

trial-borings, pronounced against the projected deep-working, as he (like Rant) believed that the stratigraphical relations were rendered unfavourable by the existence of a fault; and on the other hand, he maintained that the riam Kanan was just as easily navigable during the dry season as the riam Kiwa. A careful examination of these two rivers showed that both were unfavourable for a water-transport. During the dry months, from the end of August to the middle of October, the water-level sinks to one to two feet, so that the traffic has to be stopped for six to eight weeks. When the water is higher the rivers are navigable; but there are many difficulties in the shape of rocks, shallows, sand-banks, etc., to contend with. The length of the dangerous passage is thirty-four kilometres on the riam Kiwa, and the number of difficult places fifty, while on the riam Kanan the latter only number four in a distance of six kilometres.

The duration of the journey is, with a normal cargo (twelve tons), ten months on riam Kiwa, on the riam Kanan ("Delft") only nine; but the distance from Bandjermassin on the latter river is only forty-one kilometres, as against ninety kilometres on the riam Kiwa.

The existence of faults was, on the other hand, not admitted.[1] However, the plan for the erection of a coal-mine at this spot was not accepted by the Indian Government, on account of the cost, and the coal-mine "Delft" has never come into actual existence.

The Coal-mine Pelarang in Kutei.[2]

The Kutei coal was worked for a short time by Englishmen in the fifties.[3]

---

[1] The fault hypothesis was favoured by Rant; but C. de Groot, and later van Dyk, were against it, while Menten and Hooze pronounced in favour of it.

[2] C. de Groot B. 22, and n. T. v. N. J. XXIII.

[3] B. 12.

In 1861 the government determined to open a coal-mine in Kutei, and a year later the mining-engineer Rant was commissioned to carry out the project. Of the seven coal-seams occurring there it was decided to work two (2·3 and 1·4 metres respectively) by levels. According to C. de Groot's estimate, 20,000 tons of coal could be obtained from these two seams.[1]

The mining staff was supplied by convicts, and by Chinese miners from Bangka, and a small detachment of military was ordered there for the protection of the mine.

By 1862 the level had reached a length of 100 metres, and a railroad of 350 metres had been constructed to the landing-stage. In 1866 the level had reached a length of 200 metres.[2]

The production was in[3]—

1861	800 tons[4]
1862	1,095 „
1865	4,025 „
1872	850 „

The coal was furnished to the government steamers, and cost, up to 1864, eight florins per ton.

At the end of 1872 the mine was closed by order of the government.[5]

This mine was from the beginning only worked at irregular intervals; for very little coal was raised during the insurrection. It was hoped that it would be purchased by a private company, but this did not happen.[6]

---

[1] Jb. v/h M. 1873, I. 230.

[2] Hooze E. 14, p. 8-15.

[3] Further details are given in the list of literature.

[4] According to Everwyn (Cat. tentoon III., p. 190), the mine was abandoned in 1868, on account of the heavy expenses caused by the deep working and unfavourable results obtained. This is in contradiction with the above-mentioned facts. Perhaps what he meant is, that the mine was intended to be abandoned in 1868, but the actual closing was delayed till 1872.

[5] Jb. v/h. M. 1873, I. p. 230.

[6] Ib., 1878, II. 153.

General Remarks on the Government Coal Mines in South-east Borneo.

Of all the mines, only Pengaron plays a *rôle* of any importance. The first coal mine "De-hoop," on the riam Kiwa, only existed two years, and was then abandoned on account of its unfavourable position. Its abandonment was the cause of the opening of the mine in Pengaron.

The mine "Delft," on the riam Kanan only existed in project. It was intended to replace the mine in Pengaron.

The mine Pelarang in Kutei was opened but to provide a substitute for Pengaron coal during the insurrection; after a few years it was closed.

The mine Assahan, on the riam Kiwa, was also only opened in order to furnish the necessary coal instead of Pengaron during the construction of the works preliminary to the deep mining, and in this respect constitutes a continuation of the mine Pelarang.

The end in view in opening the mine at Pengaron was to furnish the whole of the navy with coal instead of English coal as heretofore, while it was of especial importance, in case of a possible outbreak of war, to have an independent coaling station.

This purpose was only partially successful. The Indian government vessels alone used the coal, the war-ships taking exception to it; private ships hardly used it at all, and the state railroads and harbour works of Batavia would only take it at a price less than the cost of production.

The cause of the small sale was the poor quality of the coal, and the relatively high cost of production.

The beginning of the mining was marked by a warm dis cussion as to the correct name of the mineral,—whether brown coal or pitch coal, which naturally did not tend to raise it in the estimation of intending purchasers.

A number of analyses were carried out, and practical tests were applied on board various ships. The result was always more or less favourable, and yet nobody would have the coal.[1]

The coal as such could not be brought into competition with English coal; this could only be done by considerably reducing the price. But the cost of production was not very much less than the selling price of English coal in the Indian harbours, and all endeavours to reduce its price were vain.

The chief difficulty was the insufficient means of transport, so that even with the small production all the coal raised was not removed. If the production had been large, the coal could have been furnished at a low rate, and might then have found a wide market, and the mine, perhaps, would have reached a flourishing condition; but the means of conveyance on the riam Kiwa effectually prevented this.

This chronic evil runs like a red thread through the whole history of the mines. The first mine, "De hoop," was abandoned in consequence of its unfavourable position. But the conditions were the same at Pengaron, as C. de Groot had recognised in the first years. As early as the beginning of the fifties it was decided to close the Pengaron mine on account of the unfavourable water-way, and the mine Delft, on the riam Kanan river was intended to replace it. But everything was destroyed at the latter place during the insurrection, and the project was buried for twenty years. Meanwhile Pengaron lingered on; deep mining was even begun; but the cardinal evil remained: the mine could not prosper, and there was no market for the coal. A radical cure for these circumstances had been the construction of a rail-road to Martapura, but the authorities were frightened at the great outlay involved in this project.[2]

---

[1] In these experiments the coal was selected, and the firing well looked after, conditions which do not prevail under the ordinary circumstances. Hence the wide divergence of opinion.

[2] The distance from Pengaron to Martapura is thirty kilometres as the crow flies, forty-five kilometres by water.

Thus after twenty-six years they returned to the original plan of abandoning Pengaron, and the mine was closed after thirty-six years activity.

It is extraordinary that the mine was able to drag on its existence under such circumstances so long. The cause of the evil was recognised early enough by the mining-engineers, but those in authority desired time for examination and consideration. Meanwhile the mine at Pengaron was allowed to go on.

THIRD PERIOD.

The third period of mining enterprise dates from the beginning of the eighties, and is also connected with the second period of activity of the mining-engineers in Borneo. During the twenty years in which no prospecting work was done by the mining-engineers in Borneo, nothing was heard of mining undertakings. It was their renewed activity, and the indication of the distribution and wealth of useful minerals in this country that infused new life into the promoters of mining enterprise.

In 1880, French mining-engineers (Simonar) began to prospect for gold and diamonds in Tanah-Laut, in the neighbourhood of Gunong Lawak, a district which had been completely ransacked by natives years before. They obtained a concession for a period of seventy-five years to work the diamonds, coal, gold, and platinum, in the neighbourhood of Martapura, near Tjempaka. For this they were to pay a royalty of six per cent. of the nett profit.

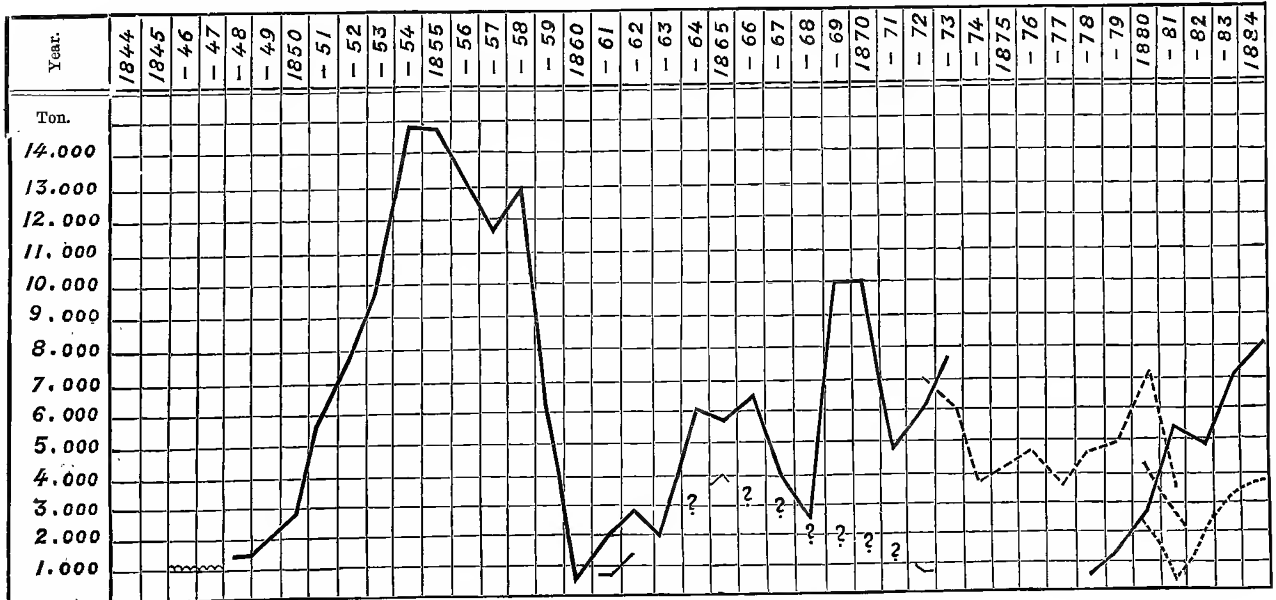
In 1882 the preliminary works were finished. Among them was a removable rail-road (0·4 metres guage).

In 1883[1] the concession passed into the hands of a

---

[1] Jb. v/h. M. 1882, II., 137; 1883 II. 161; 1884 II. 372; 1885 II. 327. Map of their territory 1882 II.

TABLE SHOWING THE PRODUCTION OF THE GOVERNMENT COAL-MINES IN S.E. BORNEO (1846-1884.)[1]



The "De-hoop" mine (1846–1847) ~~~~ near Lopignong on the riam Kiwa.
The "Pelarang" mine (1861–1872) / ? ⟍ in Kutei.
The "Delft" mine on the riam Kanan near Karang intan.
The "Oranje-Nassau" mine (1848–1884) ——— in Pengaron on the riam Kiwa. Small coal ....
The "Assahan" mine 1872–1881) - - - - - on the riam Kiwa. Small coal ....

[1] The high cost of production is in part due to the excessive administrative expenses. The annual salary of the two mining-engineers, and of the remaining European staff amounted in the eighties, during my stay in S. Borneo, to 40,000 florins, which alone added one florin to each ton of coal.

"Borneo Mining Co." the transfer being confirmed by the Indian government in 1884.

This undertaking acted as a spur to others, and many began to search for gold and diamonds.[1]

Some also also ventured on coal exploitations.

In the seventies a trading company in Batavia had begun to exploit coal in the state of Passir, but soon gave it up; while a small coal mine was worked by a private individual on the island of Laut.[2]

In 1886 a private company obtained the exclusive concession to exploit coal during a period of seventy-five years in Kutei (E. Borneo), on the R. Mahakkam, from the mouth of the R. Djawa to five kilometres above Tengaron, within an area embracing a width of 3,000 metres from each bank. The royalty to be paid to the Sultan of Kutei was fixed at 0·50 florins per ton of coal.[3]

In W. Borneo the prospecting led to no tangible results. A trading company applied in 1883[4] for permission to prospect for gold, silver, copper, and lead ores, in four places in the Chinese districts.

Tin-ore was also prospected for in Kandawangan, in the neighbourhood of Tanah-Zoroh, but nothing came of it.

North Borneo.

Sarawak.

Already in the years between 1850 and 1860, a company —the Borneo Company—was formed in Sarawak for the purpose of exploiting the useful minerals, and Gröder was for a time in its service.

The company undertook chiefly the mining of antimony and quicksilver ores (which see).

---

1 Jb. v/h M. 1885, II. p. 330.

2 Nieuwkuyk E. 12.

3 *Java Courant* 1886, II.

4 Jb. v/h. M. 1885, II. p, 330, 332,

But coal was also worked, coal mines being started between the years 1850 and 1860.[1] Somewhere between 1870–1880, the Lingga coal (Silantek coal-field) was worked experimentally; at present a company, with a capital of £200,000 is reported to be in course of formation for the purpose of exploiting it. The coal-field is of considerable extent; the dip is constant, varying only from 10° to 12° to the south or south-west.[2]

Since 1881 a government coal mine has been worked on the river Simunjan (tributary of the Sadong), and has now a regular output.[3]

The production of this mine is as follows:—

In 1880	...	...	£1,670
1881	...	...	2,460
1882	...	...	1,010
1883	...	...	9,547
1884	...	...	14,261
1885	...	...	13,759
1886	...	...	44,167

Labuan.

On the island of Labuan a coal mine existed for some time near cape Kubong, nine miles from the chief town. Soon after the island was annexed by the English in 1848, it was proposed to found a coaling-station here, and the government began to work the coal.

J. Motley[4] was the first director of the new mine.

In the course of years the mine has been worked by several companies, yet always without any success worth

---

[1] B. 12.

[2] Everett N. 23 and notes.

[3] Crocker N. 34.

[4] As is well known Motley afterwards became Director of the Julia-Hermina mine in South Borneo, and was murdered there during the insurrection in 1859.

mentioning.[1] Finally the mine came into the possession of the Oriental Coal Company in London and Leith, who had to pay a yearly rental of £1,000.

Two shafts were sunk to depths of 100 and 600 feet respectively. In one, however, there was an irruption of water which could not be surmounted. In consequence the production sank rapidly, and in the year 1879 the mine had to be closed.

The construction of a railway to the coast, a distance of nine miles had just been commenced when the accident happened, and put a stop to the work. When visited by F. Hatton in 1881, the spot was already thickly grown over.[2]

The yield was:—

In 1871	...	...	3,962 tons.
1872	..	...	3,896 „
1873	...	...	5,423 „
1874	...	...	5,288 „
1875	...	...	4,878 „
1876	...	...	5,824 „
1877	...	...	8,741 „
1878	...	...	3,717 „
1879	...	...	2,245 „

Coal was also obtained near cape Arang in the years succeeding 1880.[3]

Brunei.

In the Sultanry of Brunei coal has been worked since the eightieth decade. The coal-seams are situated at the mouth of the river Brunei, and have been exploited by the English. In the year 1888 the concession for the working of the Muara coal was purchased by the ruler of Sarawak for £120,000.[4]

---

[1] Giordano N. 19, p. 189.

[2] Everett's letters and N. 23.

[3] Hatton N. 48.

[4] *Br. N. B. H.* 1888.

The yield of Muara coal was:—[1]

In 1883	...	...	2,409 tons.
1884	...	...	4,609 „
1885	...	...	3,654 „
1886	...	...	4,491 „

Sabah.

In this, the youngest state of Borneo, no mining operations have as yet been undertaken; but the waste gold which is said to occur so abundantly in the middle course of the river Segamah is being examined, and will probably eventually be exploited Coal has not yet been worked.

Coal Mining by the Natives.[2]

Coal is worked at several places by the natives in order to cover the requirements of the steamers on their journeys to the interior, or to the east coast. A part also goes to satisfy the local demand.

Coal depots have been erected on the rivers and along the coast. The natives bring the coal to these, and it is then taken by the steamers at a fixed price. Such coal depots exist in S. Borneo at Buntok and Teweh, on the river Barito, and the coal is obtained from the rivers Suim and Teweh. On the river Negara there is a coal depot near Amunthai, the coal coming from the river Bulongan.

On the island of Laut coal was worked at Cape Pamatjintan as early as 1855 by the Prince of Kusan and Pulu Laut.[3] In 1881 passing ships were supplied by natives with coal from three mines. In the last few years the

---

[1] *Br. N. B. H.* 1888.

[2] Coal can be mined by the natives on payment of a fixed sum to the territorial princes, where these still rule. In the kingdom of Salimbau this is four florins per ton (0·25 per pikol). Jb. 1882, II. 101.

[3] De Groot S. 23, p. 64.

average yield has been 5,000 tons yearly, and the price from 6·50 to 8·0 florins on board, or 11·15 florins (according to the quality) at Java.[1]

In the kingdom of Kutei a mine near Pelarang is worked by the Sultan by means of levels. He supplies government steamers by contract at the rate of sixteen florins per ton on board.[2] Coal is raised by him in the same way near Batu Panggal. The annual yield is 2,000 to 3,000 tons. The total yield from 1872 to 1887 is estimated to be between 30,000 and 40,000 tons.[3]

Coal is also obtained and sold by the natives in Sambiliung (Berau).

In West Borneo the local demand is served by coal from Salimbau and Bunut. The princes of this kingdom also supply Indian vessels with it.

Practical Results of the Mining in Borneo.

Prospecting for useful minerals in Borneo, has, up to the present, led to results offering no great encouragement for mining operations.

The prospecting for gold-bearing veins in West Borneo, led, it is true, to the discovery of their wide-spread occurrence, but it showed at the same time that there was no prospect of their being profitably worked. The same is the case with the copper-ores occurring *in situ*.

For a long time there was much talk about the rich occurrence of iron-ores, but investigation showed this to be fallacious. It is true that they have a wide distribution, but they are not to be worked at a profit. Even the rich iron-ores in the Tanah-Laut, which were formerly regarded

---

[1] Javaverslag 1885, II. and 1886 II. In 1882 the price was fifteen florins; in 1883-1884 thirteen to fourteen florins. The coal was worked in three adits.

[2] Jb. v/h M. 1880, II. p. 23.

[3] Hooze E. 14.

as a *stock-work*[1] that would pay working, proved to be mere *lateral secretions.*[2]

A similar case is the occurrence of manganese-ores near Pengaron, on the Gunong Bessi, and a repetition of the same occurs with respect to quicksilver-ores near Tegora in Sarawak.

Ores of lead and quicksilver have proved unworkable in West Borneo.

The salt-beds and petroleum will remain untouched for a long time, so that the whole of the mineral wealth of Borneo is reduced, as far as a practical remunerative yield is concerned, to the coal-seams in the Eocene beds, for the more recent brown coal is scarcely likely to be worked on account of its poor quality.

It is here that the only results worth mentioning have been obtained. The failure of the coal mines in South-east Borneo is to be referred to unfavourable circumstances of secondary importance, good results will be obtained here also if the work is taken in hand practically, and cheap coal is supplied.

Besides the coal supply, the alluvial gold and diamonds might be made to pay, as the lower-lying valley-deposits have been shown, by recent investigations, to be in great part undisturbed. Whether this is the case will be seen in the near future.

---

1 "The name 'stock-work' is usually applied to large masses of rock intersected by a number of mineral veins at small distances apart."—*Le Neve Foster.*

2 Lateral secretions are impregnations produced by deposition from percolating waters, of matter derived from the surrounding rock.

NOTES.

To page 5, *Sarawak.*—A short time back an agreement was made between England and the ruler of Sarawak, Charles Brooke, Esq., by which England assumes the protectorate over Sarawak. According to the terms of the contract Sarawak will remain under the independent dominion of its present ruler and his heirs, protected by England. Home affairs are to be controlled by the state itself, England only stipulating for the establishment of British consulates, having, however, secured for its own state officials and for the English trade the largest number of privileges. Foreign affairs, on the other hand, are administered by England, who also retains the right to settle all territorial changes in Sarawak itself.—(*Br. N. B. H.*, 1888, August).

To p. 53.—The geological and mining investigations lasted in W. Borneo (mining-engineer, van Schelle) from 1880 to 1887; in S. Borneo (mining-engineer, Hooze) from 1881 to the beginning of 1888.

To p. 56.—*Travels of F. Grabowsky* (1881–1884).[1]

---

[1] The kind communications of Fr. Grabowsky, relative to his travels in S. Borneo, arrived unfortunately too late to permit of my treating them in their proper place; and further, it was impossible to mark his travels on the exploration map, which is the more to be regretted as his travels were as extensive as any that have been undertaken in late years in Dutch Borneo.

Fr. Grabowsky passed three and a half years (January, 1881, to July, 1884) in the southern parts of Borneo, during which time he travelled over a large extent of country. Although he was chiefly occupied with zoological, botanical, and ethnographical researches, with regard to the extent of his journeys, he takes the first position among recent travellers.

Soon after his arrival in Bandjermassin on 29th January, 1881, he was constrained, by a gunshot wound, to remain in this place till the 1st of June. He then went to Kwala Kapuas, and, travelling up the river Kapuas, reached Taran, which lies on a tributary of the Kapuas of the same name, having spent on the way some time in Kwala Kapuas and Tumbang Hiang, *To p.* 56.—*Travels of W. E. S. M. Aernout* (1884–1886).—In consequence of a letter received by me from Aernout, civil officer in Borneo, I am able to add here that Aernout's travels extended over the basins of the rivers Barito, Kapuas, and Kahajan. He travelled up the first-named stream as far as Sungei Boboat (also reached by Von Gaffron), going a little further up stream, and visiting all the tributaries.

Similarly he navigated all the tributary streams of both the last-named rivers as far as their sources, and prepared maps on a large scale. The material thus accumulated has still to be worked out. The work will contribute much new and varied information to our knowledge of S. Borneo.

In the *Tydschrift van het Nederlandsch Aardrykskundig genootschap*, 1888, *tweede Serie, Deel. V.*, No. 3, and 4, there

---

and having navigated the river Hiang for a short space. After remaining four and a half months on the Kapuas, Grabowsky passed by way of the river Mengatip, a stream connecting the rivers Kapuas and Barito, into the latter, thence into the Siran and Siong to Telan, which is situated in the district of Dusson Timor. He traversed this district in all directions, making excursions up the river Barito to Buntok, Danan, Ganting, Lihong, Bahaya, and Djana Tolai.

These journeys lasted four months. Grabowsky then returned to Banjermassin, in order to prepare for a fresh journey. He travelled to Martapura, the well known residency of the former sultans, and theuce journeyed up the river Riam Kiwa, touching at Pengaron, as far as Ranton Damar. Similarly he followed the tributary Sungei Punang, as far as the rapids of Riam malayap. Then he visited the Grotto Batu Hapu, and travelled by way of Gunong Pakan and Kampong Tambarangan to Rantau. Thence he traversed the districts lying at the foot of the Maratus mountains, visiting Kendangan, Barahei, Pringin, Amunthai, Tandjong, and climbed the mountain Rajah Klewang.

He visited the limestone grottos Lampinit, Talikor, Batu laki and Batu bini, and Siang, navigated the lake Danau Bangkan, and reached the sulphur spring Muara Imban. The river Tahaloug Kiri was navigated by Grabowsky as far as Sungei Rekon. He then crossed overland to Tanah-Laut and Gelok Limpasso, on the watershed between the Tahalong and the Barito.

After a lengthy sojourn in this neighbourhood he returned to Bandjermassin, and left Borneo on the 4th of July, 1884.

is the following paper:—"Twee reizigers in de doessœn Von Prof. C. M. Kan, and F. G. Hartmann in 1790, en de Controlleur W. E. M. S. Aernout, 1884–1886."

The first-named journey has been treated previously, and is mentioned in the list of literature, under F. S. Hartmann, S. 34.

To p. 191.—Limestone rocks near Batu Bangka, and *p.* 204, age of the same, Upper Eocene, according to Hantken.

The preliminary results of the examination of the rock specimens collected by me in this locality (Batu Bangka), and submitted to Prof. Hantken, are the following:—

I. *Rock-specimens from the marl-stage β.* (Verbeek).

A. Among the marl-limestones derived from this stage there are some whose weathered surfaces show Orbitoides (Orbitoides disparsa Sow., and Orbitoides papyracea, Boubé) in great number. On one of the specimens is a Heterostegina, which very nearly resembles Heterostegina reticulata, Rüten. The microscopic examinations of thin sections of these limestones showed that, besides the above-mentioned Orbitoides, Lithothamnium (Lith. Rosenbergi Mer.) form an essential component of these limestones. Nummulites are rare; but a species of Rotalia is of frequent occurrence.

B. A very fine-grained marly limestone also occurs between the marl-beds. On the surface of this rock no organic remains are visible; but a microscopic examination shows that it is in great part composed of minute foramnifera, sponge-spicules and remains of Lithothamnium. Among the foramnifera, Globigerinae predominate. Bolivinae also occur frequently. Besides these there is a smaller quantity of Pulvinulina, Rotalia, etc., and of sandy-shelled foramnifera, Plecanium and Gandogiora.

C. A sample of marl from the same stage was washed. The residue consists chiefly of foramnifera. An exact determination of these will be given later on. At present I can only state that among them are some species that occur frequently in the "Ofner" marls:—

Clavulina cylindrica Hantk. = Clavulina rudislosta n. sp.
Gandryina Reussi Hantk (3 Expl.)
Chilostomella cylindroides Reuss (rare).
Marginulina subbullata Hantk (rare).
Cassidulina globosa Hantk (not rare).
Globigerina bulloides d'Orb.
Globigerina triloba Reuss.
Pseudotruncatulina Dutemplei d'Orb.
Pseudotruncatulina propinqua Reuss.

Besides these there is a great number of species that will have to be carefully investigated—*e. g.*, Plecanium, Clavulina, Dentalina, Nodosaria, Glandulina, Virgulina, Bulimina, Pulvinulina, Discorbina, Rotalia, and not infrequently a small species of Orbitoides.

D. In the marl slates that form the highest beds of stage β. are only small Orbitoides and other minute foramnifera (Nodosaria, Dentalina, Pulvinulina, Rotalia, etc.).

II.—*Rock-specimens from Stage* γ. (Verbeek.)

A. Microscopic examination of sections of marl-limestone derived from this stage, shows that it consists principally of small foramnifera, agreeing in general with those of the marl-limestone *b.* from stage β. Orbitoides and Lithothamnium are of infrequent occurrence.

B. *Coral-limestone.*—The examination of sections of the coral limestones which form the upper divisions of stage β. showed that the rock mass between the coral limestone consisted principally of Orbitoides, and besides these a number of small foramnifera, which also occur in the marl-slates. Lithothamnium also occurs.

This foramniferal fauna of both divisions of the marl, leads me to refer them to the same period of formation as "Ofner" marls, and the so-called Priabona and Biarritz beds; consequently they belong to the uppermost divisions of the old Tertiary beds.

To p. 263.—For a more detailed description of the limestone caves, Batu-Hapu, Talikor, Batu laki, Batu bini, and Batu lampang, see S. 55. Fr. Grabowsky: "Kalksteinhöhlen in Sud-ost Borneo."

To p. 317.—*Occurrence of gold in the R. Segamah* (*N.E. Borneo*).

According to the report of the government engineer, R. D. Beeston, extensive gold-fields exist in the basin of the R. Segamah. Gold dust occurs everywhere in this river, from Kampong Duson on its lower course to the furthest point reached. Thus, at Batu Salawak, Pulu Rawah, Sungei Rawak, and on the islands Pulu Tis, Pulu Rabelit, and Pulu Lit Segamah. In its upper course, above the mouth of the Bole tributary, gold is of common occurrence, though in variable quantity. Of the tributaries of the R. Segamah those that lie on the right bank—*i. e.*, the waters coming from the R. are not auriferous, while those on the right bank, especially the rivers Bole-besar, Bole damit, Sabossow, and Alligator-creek, contain more or less gold.

To p. 355.—*Gold Mines in Tanah-Laut* (S. Borneo).

In Tanah Laut (section Martapura) gold-digging aud gold-washing are subject to a tax.

This tax amounted :—

In 1885	to	675·00 florins.
1886	„	742·50 „
1887	„	900·00 „

To p. 357.—*Gold exploiting by Europeans.* Two companies have been established quite recently in North-east Borneo (Sabah) for the purpose of exploiting the gold-fields in the basin of the river Segamah. These are the "British Borneo Gold Mining Company," with a capital of £100,000, and the Segamah Company, with a capital of £60,000.—(*Br. N. B. H.* 1887).

To p. 372.—*Summary of Gold-production in Montrado and Sambas (W. Borneo)*:—

Tax for 1887 ...	... ...	80·28 florins.
Value of the gold export in 1886	...	59·860 „
„ „ 1885	...	59·154 „

To p. 406.—*Platinum in Borneo.* H. Walker states that he found in the alluvial gold-tracts of the river Segamah a granular mineral resembling silver, which he holds for platinum.—(*Br. N. B. H.* 1887, p. 108).

To p. 435.—*Smelting by the natives.* According to letters received from the civil officer (consul) Aernout in S. Borneo, iron is there still smelted by the natives, but only in small quantities, and for private use.

To p. 441.—*Lead ores in Kandawangan (W. Borneo).*

The lead-ore from the R. Samarajak consists of—

Pb.	54·88	per cent.
Zn.	21·98	„
S.	19·00	„
Vein-stuff	4·00	„
Traces of Au. Ag. Sn. Fe. ...	0·14	„
	100·00	„

To p. 462.—A private company has quite recently taken over this coal-mine.

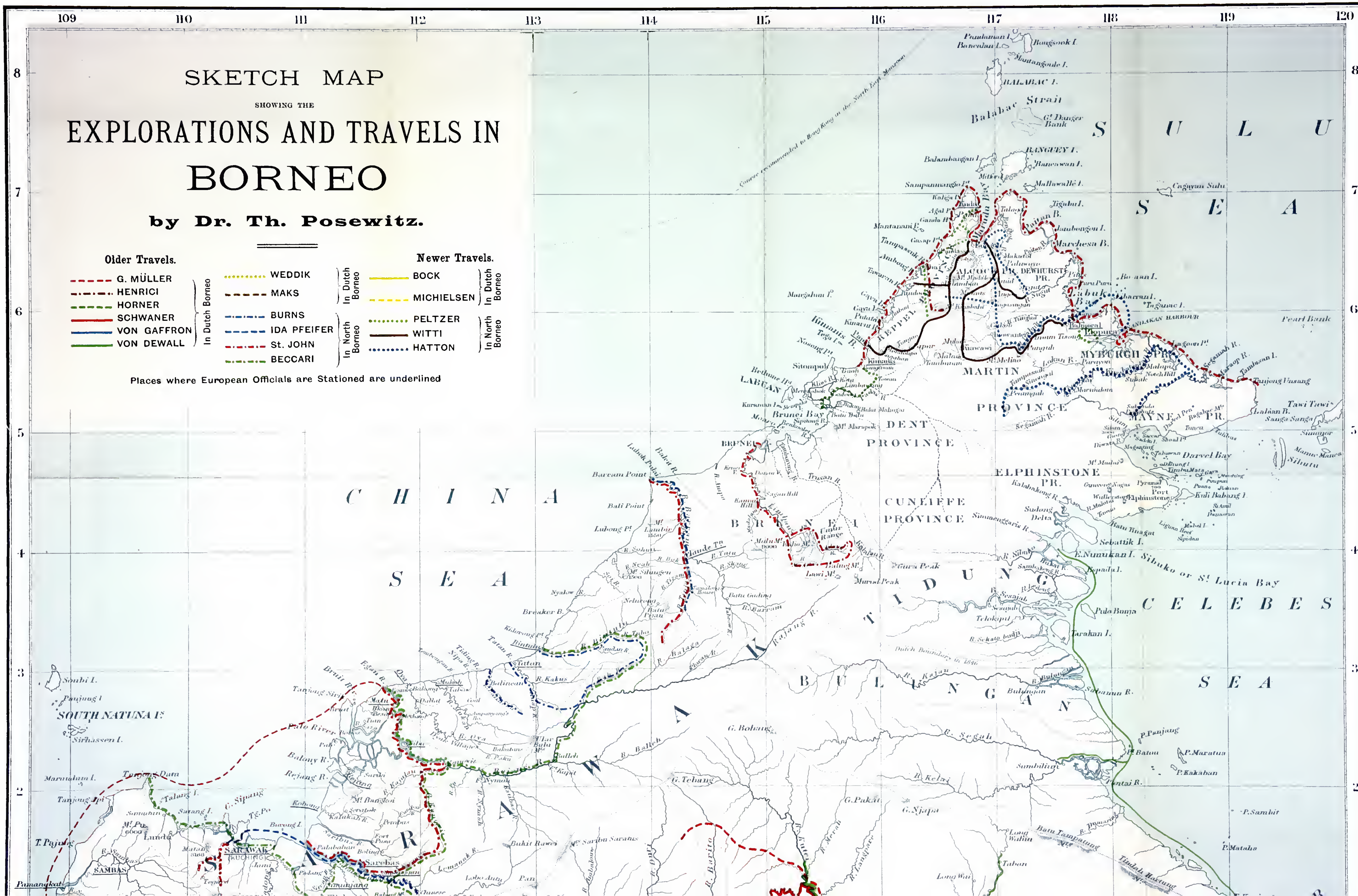
Notes on the Maps.

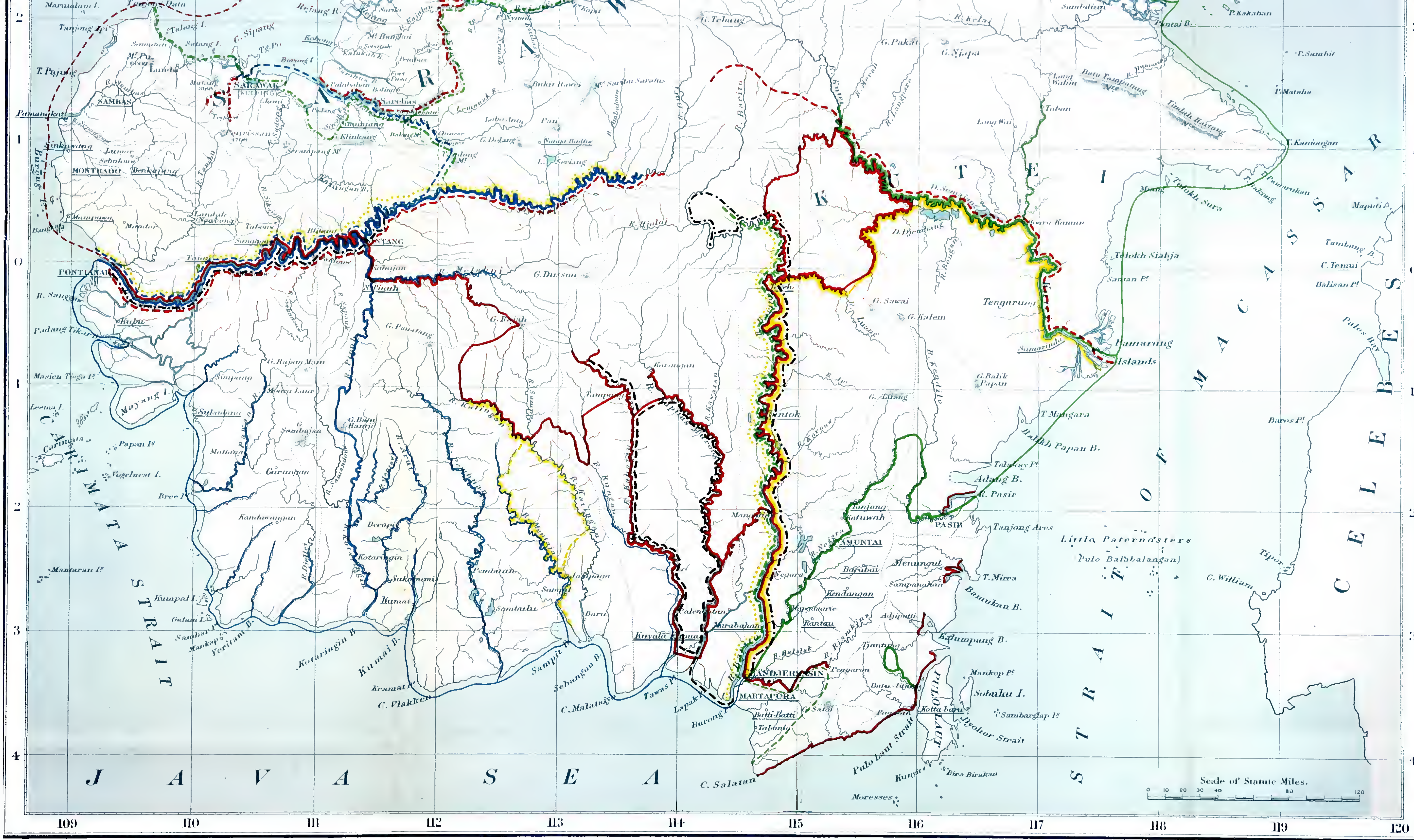
The places underlined are those where European officials are stationed.

In the map showing routes of travellers, only the more important journeys are noted. A lighter tint indicates that the exact route is not known; as, for instance, in Von Gaffron's travels in the western parts of South Borneo and those of St. John in the basin of the river Barram.

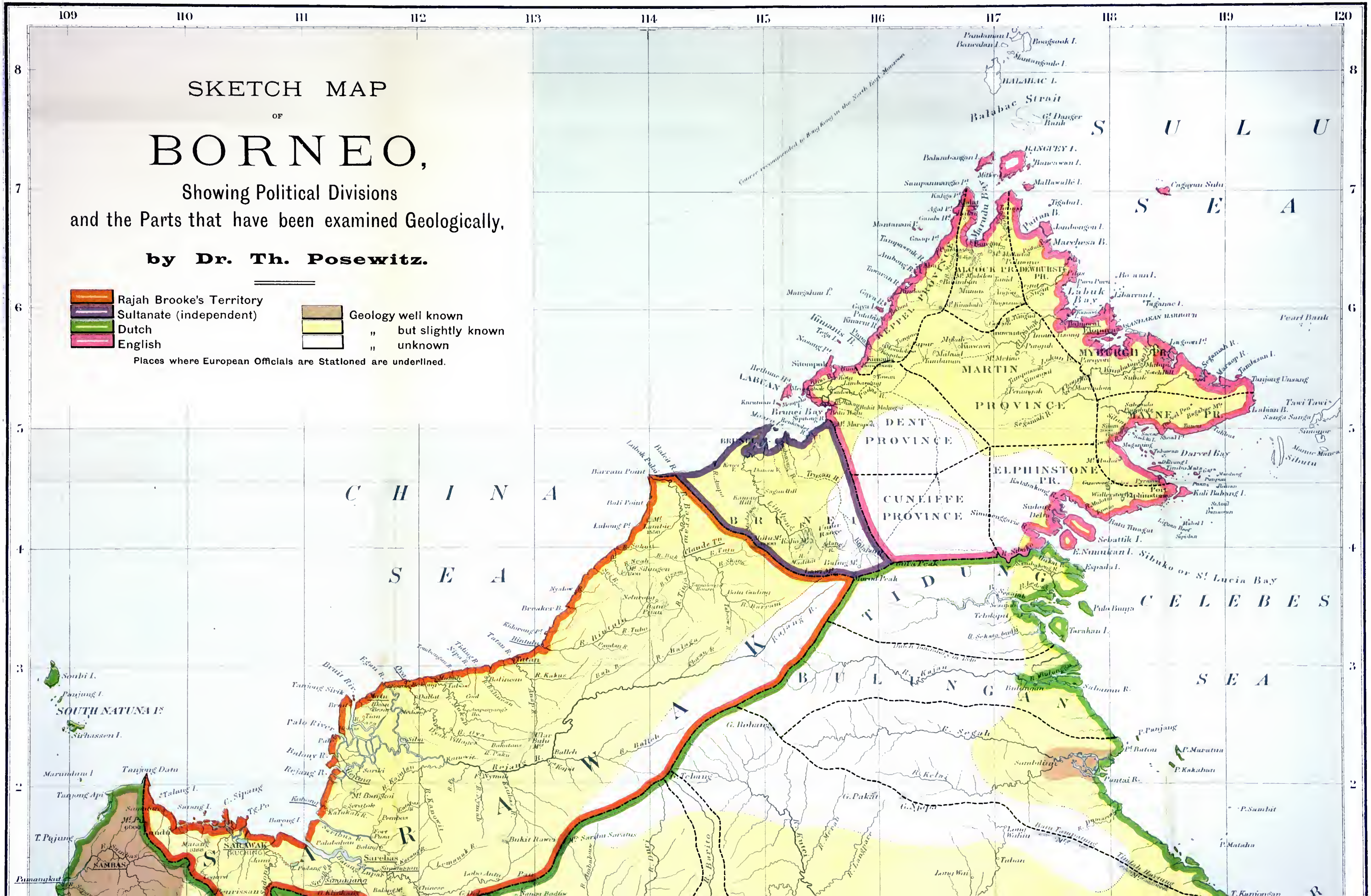
In the map showing the distribution of useful minerals, a skeleton sign is used when the exact locality is not known; as O, ⊏⊐.

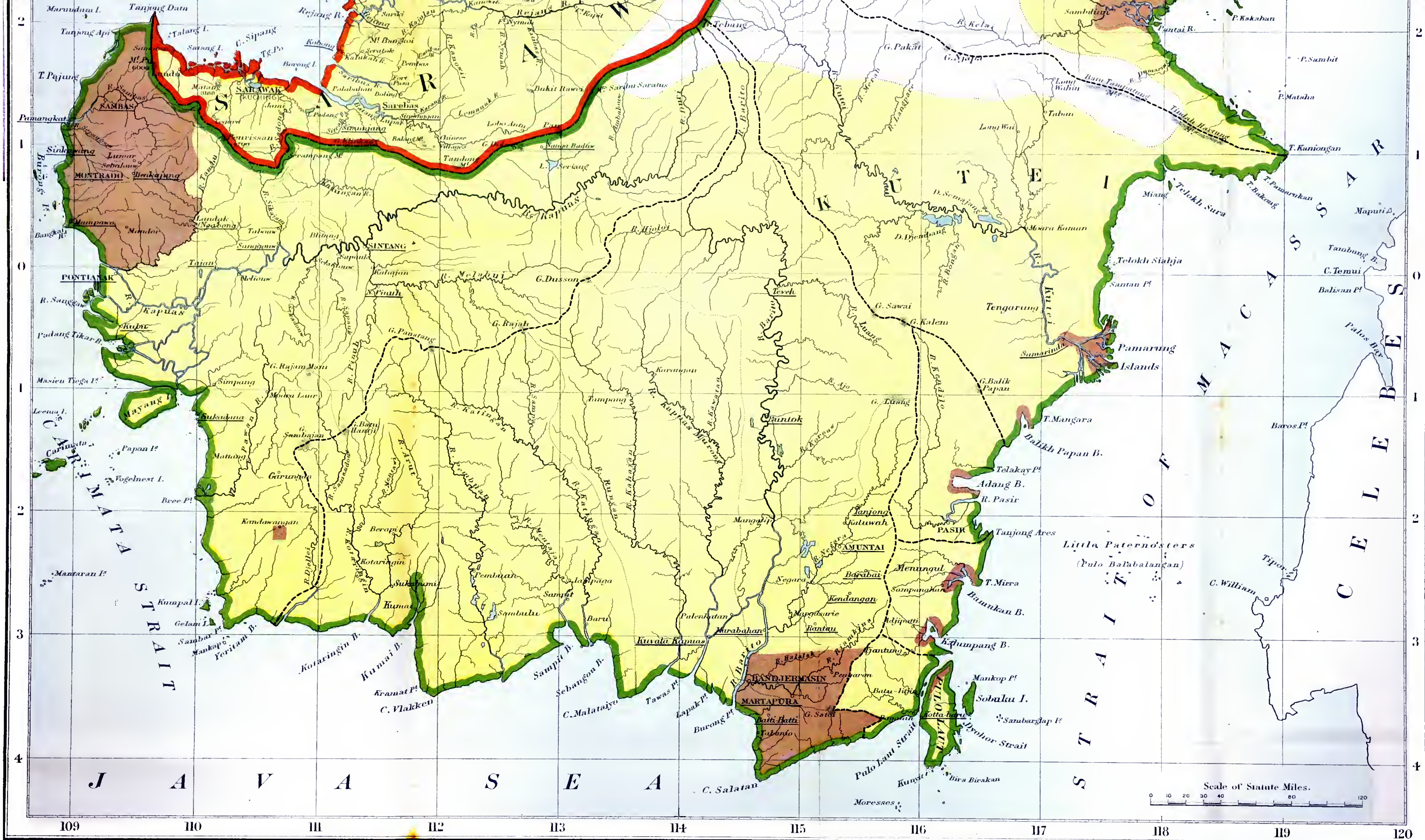
R. D. WEBB & SON, PRINTERS, DUBLIN.


SKETCH MAP
SHOWING THE
EXPLORATIONS AND TRAVELS IN
BORNEO
by Dr. Th. Posewitz.
Older Travels.
G. MÜLLER
HENRICI
HORNER
SCHWANER
VON GAFFRON
VON DEWALL
In Dutch Borneo
WEDDIK
MAKS
In Dutch Borneo
BURNS
IDA PFEIFER
St. JOHN
BECCARI
In North Borneo
Newer Travels.
BOCK
MICHIELSEN
In Dutch Borneo
PELTZER
WITTI
HATTON
In North Borneo
Places where European Officials are Stationed are underlined
109
110
111
112
113
114
115
116
117
118
119
120
8
7
6
5
4
3
2
C H I N A
S E A
S U L U
S E A
C E L E B E S
S E A
Balabac Strait
BALABAC I.
BANGUEY I.
LABUAN
Brunei Bay
BRUNEI
DENT PROVINCE
MARTIN
PROVINCE
ELPHINSTONE PR.
CUNLIFFE PROVINCE
MYBURGH PR.
MAYNE PR.
Darvel Bay
Sibuko or St Lucia Bay
T I D U N G
B U L U N G A N
S A R A W A K
KUCHING
SAMBAS
SOUTH NATUNA IS
Course recommended to Hong Kong in the North East Monsoon
Dutch Boundary in 1846



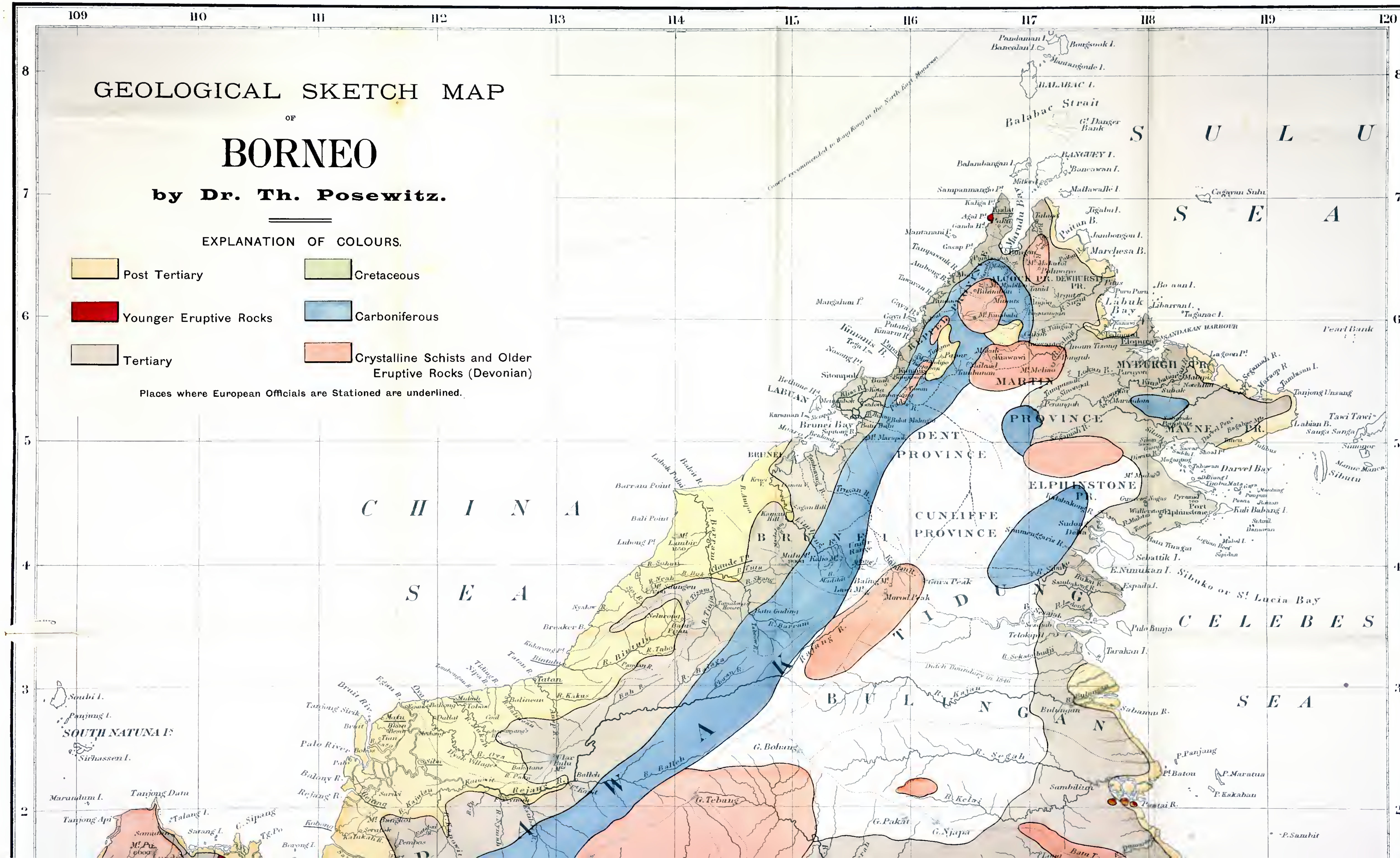
London: Edward Stanford, 26 & 27, Cockspur St, Charing Cross, S.W.

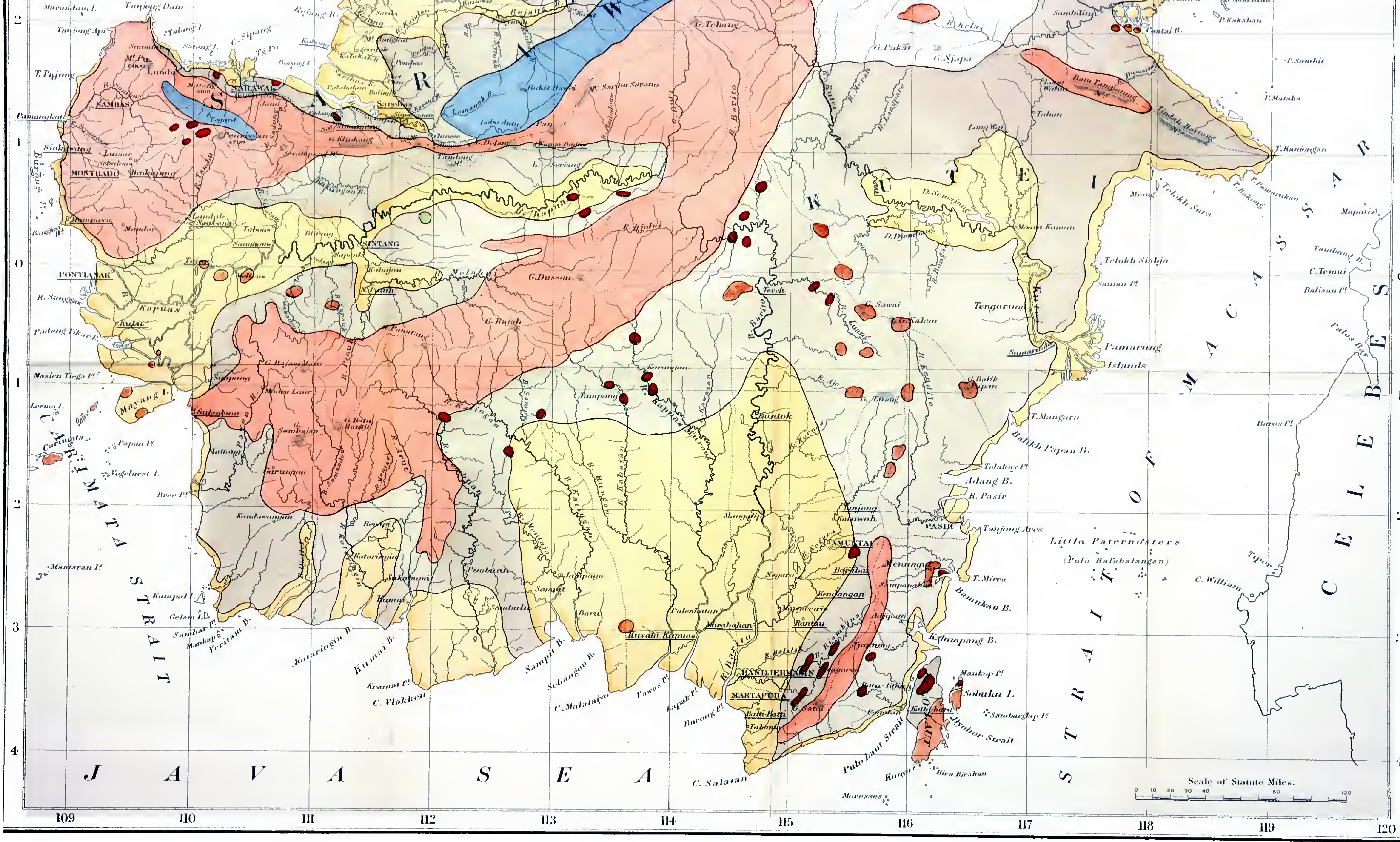

SKETCH MAP
OF
BORNEO,
Showing Political Divisions
and the Parts that have been examined Geologically,
by Dr. Th. Posewitz.
Rajah Brooke's Territory
Sultanate (independent)
Dutch
English
Geology well known
" but slightly known
" unknown
Places where European Officials are Stationed are underlined.
CHINA SEA
SULU SEA
CELEBES SEA
SARAWAK
BRUNEI
TIDUNG
BULUNGAN
MARTIN PROVINCE
DENT PROVINCE
ELPHINSTONE PR.
CUNLIFFE PROVINCE
KEPPEL PROV.
ALCOCK PR.
DEWHURST PR.
MYBURGH PR.
MANNERS PR.
LABUAN
Balabac Strait
Darvel Bay
Labuk Bay
Brunei Bay
Sibuko or St Lucia Bay
SOUTH NATUNA Is
SAMBAS
SARAWAK KUCHING
109
110
111
112
113
114
115
116
117
118
119
120



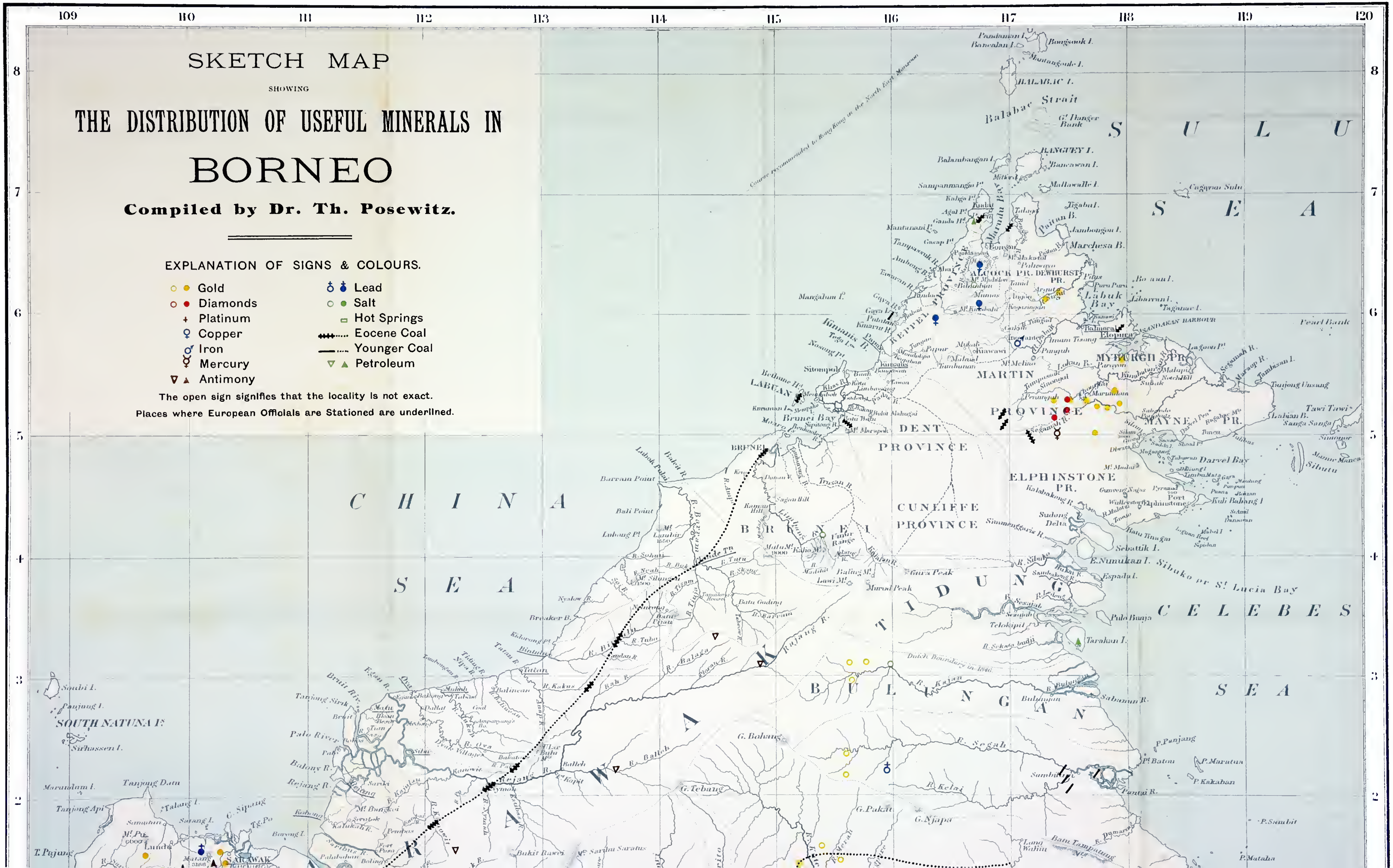
Stanford's Geographical Establishment.

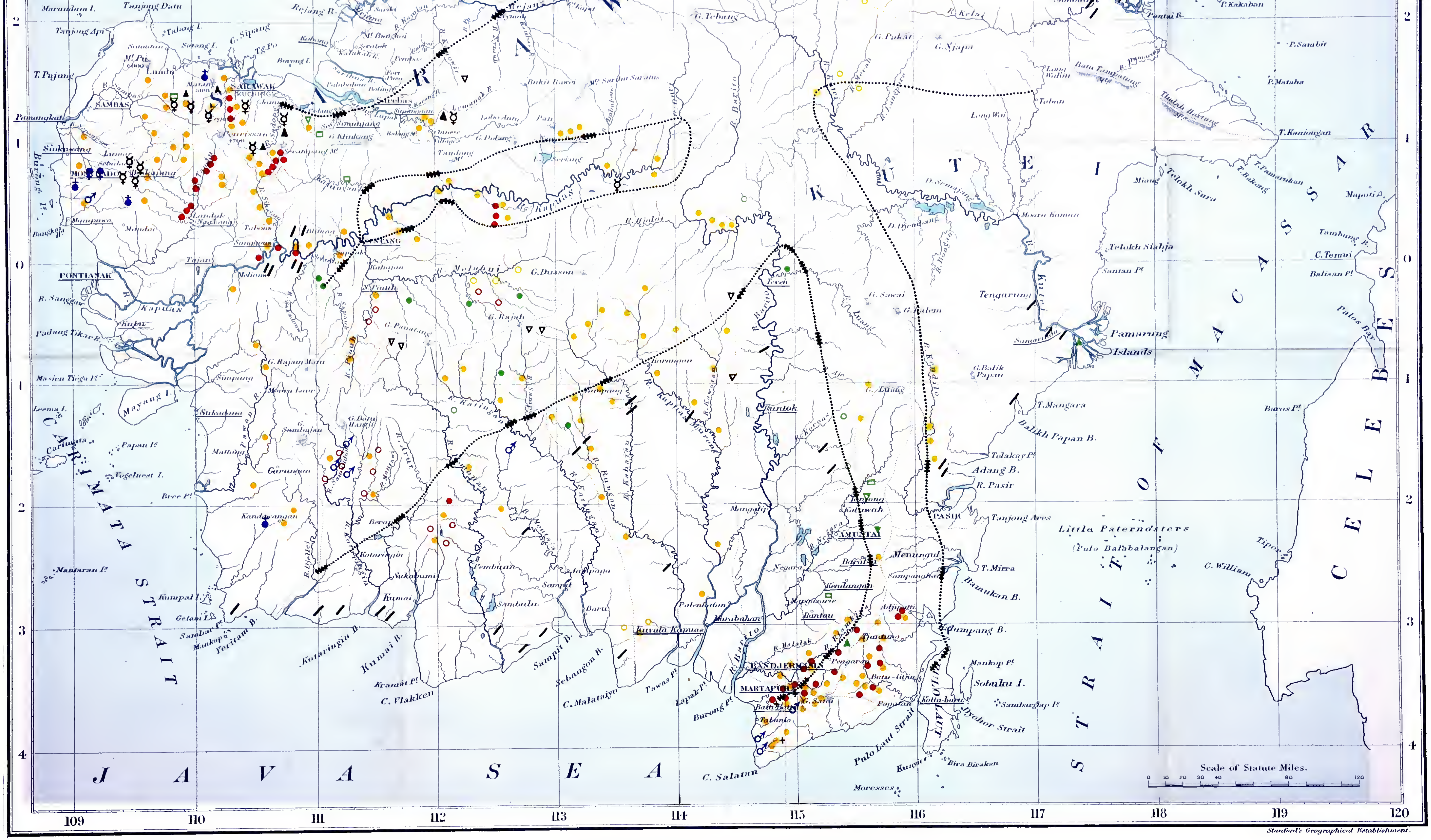
London: Edward Stanford, 26 & 27, Cockspur St., Charing Cross. S.W.


GEOLOGICAL SKETCH MAP
OF
BORNEO
by Dr. Th. Posewitz.
EXPLANATION OF COLOURS.
Post Tertiary
Cretaceous
Younger Eruptive Rocks
Carboniferous
Tertiary
Crystalline Schists and Older Eruptive Rocks (Devonian)
Places where European Officials are Stationed are underlined.
109
110
111
112
113
114
115
116
117
118
119
120
8
7
6
5
4
3
2
S U L U
S E A
C H I N A
S E A
C E L E B E S
S E A
Balabac Strait
DENT
PROVINCE
CUNLIFFE
PROVINCE
ELPHINSTONE
PR.
MARTIN
PROVINCE
MYBURGH PR.
MAYNE PR.
TIDUNG
BULUNGAN
SARAWAK
BRUNEI
LABUAN
Brunei Bay
Darvel Bay
Sibuko or St Lucia Bay
SOUTH NATUNA I.
Tarakan I.
Sebattik I.
Marudu Bay
Tanjong Datu
Tanjong Api



London: Edward Stanford, 26 & 27, Cockspur St., Charing Cross, S.W.


SKETCH MAP
SHOWING
THE DISTRIBUTION OF USEFUL MINERALS IN
BORNEO
Compiled by Dr. Th. Posewitz.
EXPLANATION OF SIGNS & COLOURS.
Gold
Diamonds
Platinum
Copper
Iron
Mercury
Antimony
Lead
Salt
Hot Springs
Eocene Coal
Younger Coal
Petroleum
The open sign signifies that the locality is not exact.
Places where European Officials are Stationed are underlined.
CHINA SEA
SULU SEA
CELEBES SEA
BRUNEI
SARAWAK
TIDUNG
BULUNGAN
DENT PROVINCE
CUNLIFFE PROVINCE
ELPHINSTONE PR.
MARTIN PROVINCE
MYBURGH PR.
MAYNE PR.
KEPPEL PR.
ALCOCK PR.
DEWHURST PR.
Balabac Strait
Brunei Bay
Labuk Bay
Darvel Bay
Sibuko or St Lucia Bay
LABUAN
SOUTH NATUNA IS
Dutch Boundary in 1846
Course recommended to Hong Kong in the North East Monsoon



London: Edward Stanford, 26 & 27, Cockspur St., Charing Cross, S.W.